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of the

ALABAMA ACADEMY OF SCIENCE

Affiliated with the
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Advancement of Science

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The Impact of the Newspaper on the Social Structure*

Vincent Townsend

The Birmingham News, Birmingham, Alabama

The dictionary tells us that "impact" is a striking of one thing against another, or on another.

The newspaper at times will have precisely this effect—but the times when it chooses to create such a deliberately-designed force on a whole people, or on some of the people, are rare.

The social structure, of course, is composed of many things. It is people. And the relationship of people with one another. This involves individual relationships—a neighbor to his neighbor, a man stopping for a chat on the street with a friend, a clergyman on his parishioner, a teacher on the pupil, a politician moving the minds of men.

One might designate any number of areas on which the newspaper has, if not a dramatic, or almost tangible, measureable impact, than a consistent influence.

It is the newspaperman's, the editor's, the executive's, belief that a steady force on the community, the state, nation or—in some hard-to-define way—the world accomplishes more for humankind than any sudden or deliberately forceful impact.

As a pressure, hopefully for the good, the constructive, one readily enough can isolate some areas where the newspaper almost daily, if not actually so, is a creative force. Let us consider some of these areas.

While the newspaper, if it is as wise as it ought to be, does not involve itself in religious matters as such, a good press will always nurture the interests of the religious establishment. It will do this in obvious ways, of course, such as giving due and desirable publicity to church meetings, problems, developments, and by pointing up in strictly objective news reports any religious issues, within a denomination—between church hierachy and subordinate congregations or clergymen, or as they may involve major decisions of doctrine or policy—the Ecumenical Council is an example; the press clarified for the general public what went on in Rome.

But the newspaper furthers the church through an advocacy of a religious people, knowing well that religion is a modifier of passions, a beneficent moderator on extremisms, and the world's most decisive influence on the living of moral lives. And out of this, of course, comes all hope for sanity in approaching any number of problems which grow on man's doorstep.

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*This paper by Mr. Townsend, vice president and assistant to the publisher of the Birmingham News, was presented before the Social Science Section but was recommended by reviewers as one of possible interest to members of all sections.

That the press is a substantial influence on schools should need little underscoring—and the term "education" itself is enough to suggest adequately how greatly important this is. For what all men learn, almost as much as the church's influences, helps determine what kind of men they are and to what ends they will direct their energies.

Newspapers, except in rare cases, do not editorially advocate educational policies, for their editors and executives often are in relatively unfamiliar ground. Yet, as regards such an issue as so-called "progressive education," the newspaper can afford a reflection of thoughtful opinion; it can bring to the fore the ideas of responsible critics or evaluators. It can sharpen the fact that, even in educational substance, there indeed is an issue of public importance.

The newspaper, everyone should know, is perhaps the most important single influence when it comes to financial support for schools. Let newspapers doubt the wisdom of an educational levy, and the enactment comes hard. It is, I think, a matter of record that rarely does a newspaper take a negative view of a school tax, unless—and this has happened—the particular tax proposed seems punitive or otherwise injurious to the general economic life of the community, state, or nation. In such event, the good newspaper's position will be that a better tax ought to be proposed if the need is established.

Newspapers have a consistent record of backing tax levies which make education at all levels possible. Currently, of course, newspapers have been doing a literally mammoth job of repeatedly bringing to the public consciousness the fact that we all had better be thinking about how we shall give higher education to the multiplying number of young people deserving of it.

I could mention that the newspaper often is used as a "textbook" in some classrooms—that is a smaller matter, in a sense, yet it reveals how intimately the press does involve itself with learning.

That man's relationship with his fellows, socially and otherwise, increasingly is a subject of governmental concern and action, especially of late on the national legislative level, is equally obvious.

And since government necessarily grows larger in an ever-increasing society, government needs the close eye of scrutiny—and the press more than any other possible instrument in a free society, at least, gives that close look daily—day in and day out—and in depth.

The social structure, as we call it, will likely ever more be influenced by government; and government, of course, grows out of, and therefore is influenced by the social structure. So, as the press reviews in detail and in theory what government does, it maintains a continuing influence—or "impact"—on the social structure.

How people live is, in a kind of final analysis, based on how much money they have—what goods and services are available to them through their own hard work and purchasing. And while there are highly specialized business or economic journals, nothing supplants the newspaper as an influence on economic thought. This influence extends at all levels—from whether a given city is in need of a new tax to make ends meet—or to enable that city to build its dreams on a large scale into something of impressive substance—or whether a nation should involve itself in foreign grants and loans—whether that nation should enter through investment into any given utility field, should cling to a balanced budget theory of financing, or take a calculated risk—at times perhaps—with deficit financing.

Without the newspaper, in its daily pursuit of facts and philosophy of practical nature, a whole people would be little equipped to form opinions as to money policy, national or local taxation, or how their own tax revenue should be spent.

It would be a dark world for most of us if only the learned, poring over economic journals written almost in a specialized language, had an influence on what was done with money—in this American or in any other free society. We have and have had ample contrasts in totalitarian societies which have not had a free press.

The newspaper involves itself in hosts of the other activities of mankind, from his leisure in sports and the place recreation has in man's life, to the careful encouragement of beauty, the arts, and humanities.

I should think a newspaper which paid great attention to medical or other scientific work, yet failed to attend the needs of man's spirit in good literature or painting or music, had not done its full job of serving as a good and constructive influence on the social order.

The newspaper virtually must seem all-enveloping, and indeed it is. It is no idle maxim of Thomas Jefferson's that a society without newspapers would be less desirable than a society without government. Mr. Jefferson's tribute to the printed word and the press is just a part of the long and impressive record that stands today to emphasize that men and institutions of high character have realized down through time that the press has a great impact on the social structure . . . man rubbing elbows with man.

James Madison said, "To the press alone, checkered as it is with abuses, the world is indebted for all the triumphs which have been obtained by reason and humanity over error and oppression."

Benjamin Rush said, "Newspapers are the sentinels of the liberties of our country."

Wendel Phillips said, "The newspaper is parent, school, college, pupil, theatre, example, councelor all in one."

C. D. Warner said, "The modern newspaper literally his its fingers reaching out toward every quarter of the globe and every finger is sensitive and every nerve brings back the treasures of the intellectual wealth that are stored up there, and a photograph of the occurrences of life that are there taking place."

Frank Stanton, president of Columbia Broadcasting System, had this to say in his Benjamin Franklin Lecture at the University of Pennsylvania: "The variety of pressures that make themselves felt in . . . society-civic organizations, academic groups, churches, the newspapers, articulate and forceful individuals—are the indirect influences that set the pace for the evolution of culture in a democracy."

These quotations are just part of the impressive recorded tribute that stands today to inspire the men and women of the American press that theirs is a great heritage, a sacred trust, and often-challenged responsibility to make an impact on the society in which they live.

There are those who abuse the trust. There are those who fail to measure up to the great challenge. But the blazing dedication that literally thousands of other men and women who give their lives to this nation's "right to know" should comfort those who often feel caught in the webs of power politics and ruthless business.

The press, as you know it today—the big city daily, the large state newspaper, the so-called junior daily which isn't a junior any more, and the weekly press that still gets right down to the grass roots of informing people at the hometown level—are all part of a most peculiar business enterprise-public service creation that makes you, the average American citizen, the best informed person in the world today.

Other media—some call it the electronic press—has moved into the American field of communications. It is alert, has power, and is struggling to reach some maturity in the information it delivers and the methods it uses to deliver that information. None can deny that the electronic press is having and will have an impact on the social structure. But the words and pictures that come to you through the electronic press are but fleeting minutes in the race of time. Once flashed on your screen they are quickly gone, never to return.

The printed word—the press of yesterday, today, and tomorrow—once on record can never be unsaid. It stands for all time. It is no fleeting impact often not seen, often not properly interpreted, that is lost to the next commercial that intrudes itself into the consciousness of the viewer.

Newspapers, because they use the printed word, have been and will continue to be man's record of his times, his achievements, his failures. Newspapers exist because people read them.

There may come a time when man is too busy to read in black and white the story of his community, his town, his state, his nation, and his world. That is not inconceivable in view of some of man's other foolish pursuits of happiness, greed, and pleasure. But for those who will pause and think . . . those who will turn a deaf ear to the politician greedy for power, the businessman greedy for excessive profits, the extremist full of hate, those who will reflect on how much of his happiness, scrutiny, culture, and progress have been charted by his newspaper will recite to himself that in the business of knowing what is going on and in communicating that information to the far corners of every community, his newspaper is unsurpassed. It is unrelenting in its quest of information and its presentation of that information. And it has man's most important contribution to knowledge—the indelible, indestructible PRINTED WORD as its sword of progress.

So the newspaper, as it follows a never-ending pursuit, creates its daily impact—or, if you want to acknowledge the word, its influences—on each man and woman.

It is a rare partnership—the civilized man with his daily newspaper before him. This partnership makes the individual—you, Mr. Average Man, Mrs. Average Woman—important to the forces of society, political, economic, cultural, religious. You cannot be ignored because you are informed.

Studies on the Vegetative Anatomy and Morphology of The Genus Gardenia*

Rebecca Deramus**

Department of Biology, University of Alabama

Gardenia is an ornamental shrub or small tree occurring abundantly in tropical to austral regions of Africa, India, China, Indonesia, Australia and surrounding areas. A few species are found in Mexico, Brazil and Jamacia (Hooker and Jackson, 1895). Although this member of the Rubiaceae includes between 60 and 100 species, very few species other than *Gardenia jasminoides* Ellis show adequate hardiness for the climate of southern North America (Bailey, 1949).

A literature survey indicates little investigation of the genus *Gardenia*. Consequently, the present paper is an attempt to define and describe the general vegetative anatomy and morphology of *Gardenia jasminoides* and compare findings with information from investigations on other Rubiaceous genera.

The only comprehensive study on the vegetative morphology and antomy of *Gardenia* is that of Metcalfe and Chalk (1950) who gave a comparative analysis of the general vegetative features of the genera in the family Rubiaceae. Laurie and Duffy (1948) described abscission of *Gardenia* buds from an anatomical viewpoint and showed that cellular dissolution progresses centripetally with respect to parenchymatous tissue of the cortex. Subsequently, the xylem vessels undergo mechanical breakage to complete separation and the phellogen develops a cork layer over the exposed tissue. G. C. Mitra (1948, 1960) investigated interpetiolar stipules in the Rubiaceae with emphasis on *Paederia foetida* Linn. and *Ixora praviflora* Vahl. It was found that the vascular supply to stipules is derived from lateral traces of the trilacunar leaf trace in *Ixora parviflora* and from branches of a unilacunar leaf trace in *Paederia foetida*. In the present study it was found that in *G. jasminoides*, stipules receive their vascular supply from branches of the lateral leaf traces as in *Ixora parviflora*. Adnation and united growth of

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basal portions of stipular and foliar tissue, as noted in *Ixora pruviflora,* also occurs in *Gardenia jasminoides.*

Pal (1959) described the origin and vascularization of stipules and axillary buds of *Gardenia* and other genera in the Rubiaceae. His observations on nodal anatomy in *Gardenia lucida* Roxb. were very similar to findings in *Gardenia jasminoides* presented in the present paper. He also describes *Gardenia Thunbergia* L. as having a trilacunar node and close leaf-trace bundles. A study of hand sections of *Gardenia Thunbergia* confirmed his data. From brief observations during the present study, *Gardenia spatulifolia* appears to be similar to *Gardenia Thunbergia* in its stele shape and pattern of trace position and migration. In both species prior to trace formation the vascular cylinder elongates into a rectangular to elliptic shape. The small lateral leaf traces originate in close proximity to the median trace.

In referring to the lateral traces the terminology can be confusing, especially when dealing with lateral traces which originate at quite a distance from the median trace as in *Gardenia lucida* and *Gardenia jasminoides.*

They may be considered as lateral leaf traces or stipular traces since branches migrate to both leaf and stipular tissue. Pal prefers to consider them as lateral leaf traces since they migrate into what he refers to as the collar, and then branch into the stipule and petiole. If the collar is considered as united leaf base margins and the stipule and petiole as outgrowths of the collar, his termindology seems justified. For purposes of clarity and simplicity in the present paper they will be referred to as lateral leaf traces. In studying axillary buds Pal concluded that those in *Gardenia* are both axial and foliar in origin. The foliar ones are ephemeral, develop near the shoot apex and receive a vascular supply from the leaf trace. The buds which are axial in formation and develop in a more mature region on the stem receive their vascular supply from the central stele and develop into major branch systems.

Majumdar and Pal (1958a) investigated the interpetiolar stipules of *Galium mollugo* L. and described several stipular patterns found in the family Rubiaceae. They (1958b, 1958c) also compiled data on the comparative structure and development of stipules within 15 genera of the Rubiaceae. Stipules of *Gardenia florida* L. were described as trilacunar, connate and sheathing, and the phyllotaxy as opposite or occasionally in whorls of three leaves.

MATERIALS AND METHODS

A useful technique employed was the paraffin method described by Johansen (1940), Gray (1954) and Sass (1958). Plants were killed and fixed in formalin-aceto-alcohol, dehydrated in the normal butyl alcohol series, infiltrated with Fisher "Tissuemat", sectioned, mounted with Haupt's adhesive, stained with safranin and fast green and mounted in Permount.

Secondary stem growth studies were made with the aid of a sliding microtome. Sections were stained with safranin and fast green within the ethyl alcohol dehydration series, cleared in xylol and mounted in Permount.

DESCRIPTION

Gardenia jasminoides has a multi-branched extensive taproot system. Frequently the root branches immediately below the soil surface. Transverse sections display a loose-formed, thin-walled epidermal layer, a fairly extensive large-celled cortex, an obscure endodermis and a siphonostele with a pericylce and limited pith. The endodermal cells contain thin casparian strips which become more distinct and regular in the stem tissue. Within the stele patches of protoxylem and protophloem occur in an alternating arrangement. As the metaxylem differentiates centripetally the phloem develops laterally to form arcs or wedges of tissue between the patches of xylem. Conconmitantly, the pericycle and endodermis are obliterated and the cortex increases sizeably in diameter.

The transitional zone shows a splitting, rotation and fusion pattern of the vascular tissue which resembles Type B in the table of diagrams, p.294, as given by Eames and McDaniels (1947. Both xylem and phloem fibers increase in number from root to shoot. The movement of the xylem is a pivoting action; the position of a particular xylem bundle remains fairly stable with respect to its orientation within the stele and the stem. The xylem fibers do not encircle the stem before entering the leaf trace. The bundles split in an anticlinal plane with reference to the main axis and each half begins to rotate laterally in opposite directions (Fig. 1-3). The innermost metaxylem leads the migration and becomes the outermost xylem element of stem tissue. The protoxylem becomes aligned adjacent to the pith. Throughout most of the stem tissue, the xylem is in rotation and the phloem remains unchanged. Near the shoot apex the arcs of phloem split and migrate to form a discontinuous ring around and xylem and pith. The xylem stands become oriented in the same radial plane with and inside patches of phloem tissue, thereby creating ovoid or circular vascular bundles. Concomitant with this joining there is a migration of most of the vascular tissue, particularly the metaxylem, into the cotyledon traces (Fig. 6). Two small bands of primary vascular tissue which are adjacent to the traces and opposite each other continue vertically until a transition can be seen from vascular strands to procambial tissue near the shoot apex.

The shoot epidermal layer as seen in transverse section is slightly but regularly grooved and ridged; this pattern represents an external characteristic which has no apparent relationship to an internal development or process. The epidermal cells have from four to ten chloroplasts per cell and relatively thin cell walls upon which are deposited abundant patches of cutin. The cortical parenchymatous cells are large, thin-walled, contain a few chloroplasts, druses and aggregations of calcium oxylate crystals. The endodermis and pericycle are fairly distinct and encompass the vascular cylinder. The phloem forms an outer ring which circumscribes the metaxylem, protoxylem and pitch. The metaxylem shows helical thickenings of the secondary wall. With the increasing proliferation of metaxylem cells, the protophloem becomes obscure and the pith remains limited. In older plants the new spring growth of the stem is green to light brown and is covered by a scaly membrane which bears short, straight, non-cellular protuberances. This membrane represents desiccated epidermal cells and deposition of cutin on outer walls. This gives the young stems a coarse, rough external texture. During stem maturation and internodal elongation, this cuticular layer together with the epidermal layer is sloughed off in thin sheets. Concurrently the vascular cambial cells divide and the stem expands laterally.

A transverse section at this stage indicates several changes through vascular cambium activity and primary tissue specialization. Simple trichomes develop from epidermal cells. The conspicuous grooves become obscured by the increased diameter of the stem. The outer cortex is more compact, contains chlorophyll and with age shows a proportional decrease in width when compared with the increasing area of the parenchymatous pith. The cortical cell walls show abundant pitting. Between the xylem and phloem the vascular cambium differentiates from elongate procambial cells and, synchronized with the interfascicular cambium, forms a uniform, continuous cylinder of secondary vascular tissue in the stem. The number of pith cells increases considerably as the stem expands in diameter; cells show extensive depositions in the form of druses and crystals.

In mature wood of *Gardenia* the bark is thin, fairly smooth, and either totally black or dark brown with irregular green splotches. The periderm is elaborated in irregular arcs and shows a tendency to flake off in sheets or thin layers. Lenticels are abundant and conspicuous as are the stipular scars which enricle the node. The wood is moderately dense and heavy with abundant thick-walled libriform fibers, tracheids and fiber tracheids in the secondary xylem. The vessel elements are advanced, with simple perforation plates and little or no end-wall inclination. In distribution, vessel elements are solitary, diffuse porous, and abundant throughout the growth rings. They measure from 0.03 to 0.05 mm in diameter and from 0.20 to 0.50 mm in length. The secondary wall appears to be moderately thick and evenly distributed. Tertiary thickenings, as diagrammed on p. 30 of Eames and McDaniels (1947), were noted in a few vessel elements.

Scattered throughout the secondary xylem are abundant heterogeneous uniseriate and multiseriate rays. In height they range from eight to twenty cells, in width from one to four cells. The extensive length of the rays may be attributed to the rows of narrow tapering upright cells extending in both directions from the central procumbent cells.

Xylem parenchya is apotracheal in distribution. These cells usually occur in long tapering vertical chains and show development of unusually thick side walls with abundant simple to transitional pitting. These parenchymatous cells show great similarity to septate fibers which are sclerenchymatous cells also elaborated by the vascular cambium. At a certain point the distinction between the two cell types becomes very tenuous and seems to lose validity. Identification was aided by the fact that their wall structure closely resembles that of the ray cells. Due to bizarre secondary wall deposition, some walls of the parenchyma cells appear looped or loosely coiled. The pitting is irregularly shaped, abundant and simple to bordered.

The phloem is fairly small in extent and is characterized by sieve tube elements having moderately thick, uneven walls with abundant sieve areas on side walls, and in sectional material, slime plugs near the end walls. The secondary phloem contains slight amounts of crystals and druses. External to the phloem is a narrow cortical layer which is circumscribed by a distinct band of large brachysclereids. The cortical cells appear tightly-packed, moderately thick-walled and abundantly pitted. Another layer of cortex separates the brachysclereids from the cork cells of the periderm. These cells are densely impregnated with suberin and possibly other fatty substances or storage products. They are small, square to rectangular as seen in transverse section, and are arranged in distinct rows due to periclinal divisions of the cork cambium.

A possible diagnostic character in the genus *Gardenia* is the nodal anatomy of the stem. In *Gardenia jasminoides*, as in the other available species, each node has two or three leaves but no regular pattern is discernable. This phenomenon does not appear to be correlated with the number of cotyledons formed. Only in *Gardenia spatulifolia* was there found an occasional development of three cotyledons, two of which were partially fused.

Above the node is a thin, membranous, sheathing intrapetiolar stipule, the tips of which attain lengths up to two cm. After internodal elongation and the development of axillary branches, the stipule gradually becomes scarious and desiccated, splits down one or two sides, and finally is sloughed off. Of interest is the manner in which traces migrate to these leaves and to the sheathing stipules. Approximately two cm. below the node the oval vascular cylinder develops flattened, depressed areas which later develop into median leaf traces. Centrifugal migration of the traces begins at approximately three to five cm. below the node. To a certain extent the formation and rate of migration of median and lateral leaf traces appear to be synchronized. The number of lateral traces per median trace varies from two to four and their migration occurs more rapidly and irregularly than that of median traces. As the median traces approach the petioles the lateral traces branch and migrate laterally in the collar. The collar is composed of leaf bases whose marginal extensions have fused. The petiolar and stipular tissue arise from the collar (White, 1955; Pal, 1959). At this point the collar is delimited from the stem tissue. Separation begins in the interpetiolar regions. Often a sclerenchymatous, coriaceous layer develops between the stipular and petiolar bases and the stem tissue.

Internally the stipule is composed of from five to ten layers of tightly-packed, chlorophyll-containing, parenchyma cells among which are scattered branches of lateral vascular traces. Crystal sand and druses occur frequently in the stipule. On the abaxial surface of the stipule are unicellular, simple, thick-walled trichomes; on the adaxial side are elaborate multicellular trichomes.

Adnation of the swollen petiolar and stipular bases allows for migration of lateral trace branches into petiolar tissue. Some branches join the median leaf trace, others remain in the peripheral tissue of the short petiole and pass into the blade as marginal foliar veins. In the petiole the traces appear to be concentric with respect to the orientation of vascular tissue.

Also of interest in the study of nodal anatomy is axillary bud development. The branch or axillary stem usually remains adnate to the main stem for a short distance before separation occurs. The vascular trace to the axillary bud appears immediately following movement of the median leaf trace into the petiole, and is produced by migration and convergence of vascular tissue from each side of the leaf gap. The branch trace remains as a continuous segment of the main stele until immediately before branch divergence. In correlation with other data the stelar structure seems strongly to suggest that the internodal growth of the main stem and axillary branch is synchronized and interrelated.

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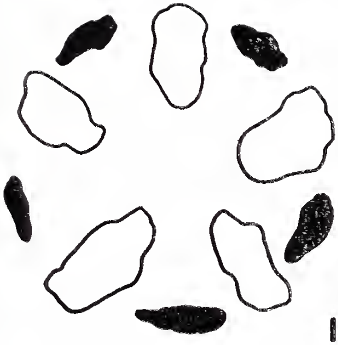

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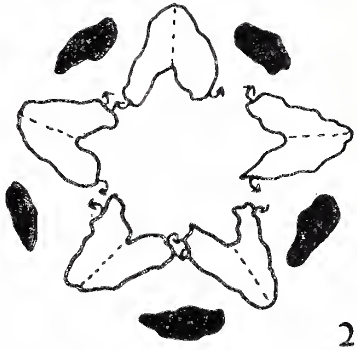

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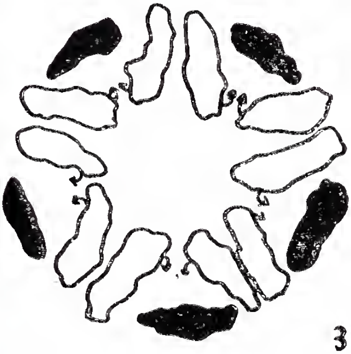

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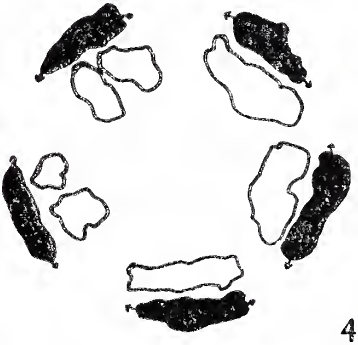

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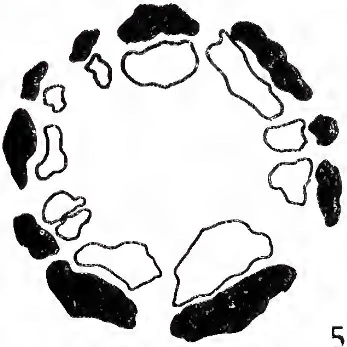

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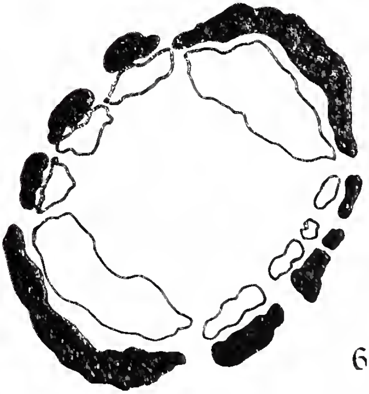

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PAL, P. Developmental studies IV. The origin and vascularization of the stipules and axillary buds of *Gardenia, Portlandia, Randia, Mussaenda, Luculia, Coffea, Adina, Morinda, Hymenodictyon, Hamiltonia* and *Rubia*. Proc. Natl. Inst. Sci. India. 25:279-299. 1959.

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LEGEND FOR FIGURES ON PRECEDING PAGE

Transverse sections of the vascular cylinder of *Gardenia jasminoides* seedling. Figures 1-6 represent progressive stages from the radicle toward the shoot apex. Black areas represent phloem; white areas, xylem.

1. Radicle section showing the alternating pattern of xylem and phloem.

2. & 3. Hypocotyl region. Note the splitting and migration of xylem bundles.

4. & 5. Hypocotyl region showing an increase in the number of phloem and xylem bundles.

6. Stem tissue near the shoot apex showing a lateral migration of vascular tissue into two large patches. Eventually, these form cotyledon traces.

Minimum Resource Requirements and Resource Adjustments for a $5,000 Farm Income in the Wiregrass Area of Alabama

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One of the major problems confronting agricultural policy makers today is the continuing imbalance between farm and nonfarm incomes. Today, average nonfarm income far exceeds average farm income, indicating that resources are not being allocated rationally between the agricultural and nonagricultural sectors of the economy. If this mis-allocation could be corrected, the result would be to increase the rate of economic growth and the welfare of the nation. Future agricultural adjustments and policies must be viewed within the context of the national economy rather than within the agricultural sector alone.

This study was designed to serve as a guide in the allocation of resources between the agricultural and nonagricultural sectors of the economy. The primary purpose is to suggest conditions necessary for effective agricultural adjustment programs in the area. A second objective is to provide information that will be valuable to individual farmers in choosing among alternative production opportunities. Specifically, the study was initiated to determine the minimum amount of open land necessary to yield a specified net income in the Wiregrass Area of Alabama.

A $5,000 return to operator's labor and management was selected as the income goal. This figure represents about the average income of a semi-skilled industrial worker in the area. Linear programming techniques were used to determine the minimum open land requirements for the desired income under alternative levels of factor prices and enterprise combinations. Before the linear programming technique could be applied to a problem of this type, it was necessary to determine: (1) inputs required for each of the activities on a unit basis. For crops, a unit was one acre. For livestock enterprises, the units were ten sows, fifty steers, and one hundred beef cows; (2) prices for all inputs and products; (3) expected yields per unit; and (4) net returns per unit of production. Land and labor prices were varied above and/or below existing price levels in the analysis. The current price for an acre of open land was determined to be $105, and the similar figure for hired labor was $0.60 per hour. Regular operator labor was charged at $1.00 per hour.

One operator and a fixed complement of two-row machinery and equipment were assumed to be on each farm. Improved production techniques were utilized in all programs. Capital was not a limiting factor.

Since land was being minimized, it was not likely that enterprise organization would change with rising land prices. However, more land would be necessary to reach the desired income level as production costs are increased by higher land prices. The magnitude of this change in farm size was measured by using five annual land charges. These charges were based on: (1) full ownership of land; (2) $52.50 per acre; (3) $105 per acre (assumed current price); (4) $157.50 per acre; and (5) $210 per acre. For full ownership, the only charge was $1.00 per acre for taxes. For the remaining four land prices, the annual charge included interest at five per cent, in addition to taxes.

Future increases in the price of labor could affect both open land requirements and farm organization. Labor intensive enterprises would tend to be replaced by those using labor less intensively. To investigate these effects, programs were computed with labor at: (1) base or current prices; (2) 50 per cent above base prices; and (3) 100 per cent above base prices. These price changes applied to both resident labor and hired seasonal labor.

The enterprises selected as alternatives were all land based and included cotton, peanuts, corn, oats, wheat, soybeans, grain sorghum, Coastal bermudagrass, steers, hogs, and a beef cow-calf operation. Assumed yields were predicted for typical weather conditions in the Wiregrass Area. No attempt was made to vary either crop yields or product prices. Typical per acre yields were cotton (594 pounds), corn (55 bushels), and peanuts (1,800 pounds).

Four sets of enterprise possibilities were considered. One combination of programs included all activities, while the three remaining combinations excluded: (1) sale of Coastal hay; (2) hogs and steers, and (3) hogs, steers, and Coastal hay.

RESULTS

Under the price conditions assumed for this study, producing Coastal hay for sale would be a profitable alternative in the Wiregrass Area. To obtain a $5,000 net return to operator's labor and management, 117 acres of open land were required when Coastal hay was included among the alternatives. Excluding the hay selling activity increased the minimum land requirement to 137 acres with steers replacing Coastal hay in the list of enterprises. When hogs and steers were excluded, but hay selling permitted, the land requirement was only 122 acres. When hogs, steers, and Coastal hay were excluded, the minimum open land requirement increased to 168 acres.

Increasing or decreasing the land price increased or decreased the minimum land requirement. However, within each set of enterprise possibilities, varying the land price did not change the proportion of each enterprise in the optimum farm organization. Increasing the land price from $105 to $210 per acre increased the minimum land requirements from 117 acres to 131 acres when all enterprises were considered.

Varying the labor price had little effect on land requirements for a $5,000 return and affected the optimum enterprise combination only when hay selling was permitted. In the latter case, doubling the current labor price increased the land requirement from 117 to 127 acres.

Within the Wiregrass, there were 20,070 farms, according to the 1959 Census. From 16,000 to 18,000 of these farms were below the minimum size necessary to attain a $5,000 return to operator's labor and management under the assumptions of this study. If these 16,000 to 18,000 farms were reorganized into farms of the minimum size necessary to obtain a $5,000 net income following the assumptions in this study, total farm numbers in the area would decrease 48 to 63 per cent.

In 1959, only 22 per cent of the farms in the Wiregrass area met the minimum acreage requirement of 117 acres. Assuming the farms already at or above the minimum acreage requirement are not to be adjusted, farm numbers would have to be reduced by 48 per cent to provide a $5,000 return to all operators.

The adjustment required, assuming land sold for $210 per acre, would result in the largest reduction in farm numbers among the solutions in this study. Currently, only 10 per cent of the farms in the area possess the necessary 197 acres of open land. For all farmers to receive, at a minimum, a $5,000 net return, it would be necessary to reduce the number of farms from 20,070 to 7,360, a decrease of 63 per cent.

IMPLICATIONS

The results of this research indicate that cotton and peanuts are the two most profitable enterprises within the Wiregrass. In all instances, these two crops were initially selected and their production was limited only by the acreage allotment.

Results also indicate that it is more profitable to feed corn to livestock than to sell corn. In all solutions, corn was more profitable than oats, wheat, soybeans, and grain sorghum. The latter three enterprises failed to enter any farm organization under the assumed price conditions.

Of the three livestock activities, hogs appeared to be the most profitable with steers and beef cows following in order. Steers failed to compete with hogs except where hay selling was eliminated.

Even under favorable price assumptions, three-fourths of the farms in the Wiregrass have too few land resources to attain a $5,000 return to operator's labor and management. Farm numbers in the Wiregrass have steadily declined over the past ten years. If migration from the farm to the nonfarm sector continues at the same rate as during the past decade, the necessary reductions in farm numbers could possibly be attained in 12 to 14 years.

Displaced agricultural workers would need training for employment in other fields in most instances. New programs to expedite this training would aid the transition from the farm to nonfarm employment. In 1959, the average age of the farm operator in the Wiregrass was 48 years. Training a man of this age for new employment presents many problems, paramount among which is the low return on investment received by industry for training and employment of an older worker. The training problem is further complicated by the low educational level of many farmers.

It is obvious, of course, that the adjustment process will require time. The farm problem is not subject to any quick and easy solution. Major farm programs over the past two decades have only helped to prolong the problem.

The real solution lies in education and retaining of farm people for other employment. Heady[1] has summarized the importance of education in solving the low-income problem in agriculture in these words: "Proper education, with the research to support it, cannot alone effect the transfer of all surplus farm labor, but it can be the important catalyst in bringing about adjustments required in a rapidly growing and full-employment economy."

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[1] HEADY, EARL O., *et al. Agricultural Adjustment Problems in a Growing Economy.* Ames: Iowa State College Press, p. 15. 1958.

ABSTRACTS

Biology

Relation of Aspergillus flavus Invasion to Maturity of Peanut at Harvest

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Peanuts (*Arachis hypogaea* L. var. Early Runner) were hand-picked from plants or ground immediately after digging and separated into immature, mature, and overmature-damaged categories. Peanuts within each category were separated on a basis of pod color, appearance, and location on the plant. Samples of peanuts picked the same day (cured in the field five or six days) and samples in storage for three days were also collected. Each lot was surface-sterilized (in the field) for two minutes in 1:3 clorox solution, air-dried for five minutes, and placed in polyethylene bags in an ice chest. The following day, samples were carefully shelled in the laboratory and microfloral analyses were made by standard serial dilution technique. In addition, 50 peanuts (100 kernels, 100 pod halves) from each treatment were plated on Czapek's agar containing 20% sucrose.

Microfloral data showed that *Aspergillus flavus* was present only in the overmature-damaged peanuts in the amount of 100 spores per gram of peanut kernels. Results of plating studies revealed that 2% of the mature and 8% of the overmature-damaged kernels were infected with *A. flavus*. Of the pods (hulls) plated out, 1% of the immature, 9% of the mature, 55% of the overmature-damaged, and 6% of the three-day-stored lots were invaded by the fungus. Thus, there appears to be an increase in *A. flavus* invasion of peanuts with time as measured by maturity of the peanut fruit.

Geology And Anthropology

A Construct of Projectile Point Styles Indicating A Hypothetical Cultural Development

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When the general form, style of character of an artifact distinguishes a particular kind, class or group it is called a type.

Types are admittedly arbitrary, and a given type cannot be expected to correspond with the entire cultural development of which it is a part. However, in a stratified excavation those objects showing stylistic similarities which are found within an undisturbed stratum can be assumed to have cultural relationship.

Cultural relationship can also be assumed when certain stylistic characteristics are retained even though the overall form exhibits a new type. It is the attempt here to construct within the Paleo Indian and Transitional Paleo Indian stages a stylistic development in projectile point types which may indicate a cultural evolution. Such a stylistic development begins with the Clovis—a fluted projectile point, the earliest type presently recognized to be in the Southeast—and progresses through intermediate mode changes to the fluted Cumberland. From the Cumberland can be demonstrated, purely on stylistic changes, the development to the unfluted Beaver Lake and hence to the Quad-Dalton range of types, in which occasional fluting occurs. Similarly, the development can be shown, through style changes, to the Hardaway and Big Sandy I side notched types. At the present time excavation stratigraphy has demonstrated the true cultural relationship of only Beaver Lake, Quad, Dalton and Big Sandy I within these Paleo Indian and Transitional Paleo Indian stages. More excavation is needed to complete the picture.

Forestry, Geography And Conservation

Some Plant-Habitat Relationships in the Longleaf Forest of Southwestern Alabama

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Twenty-four understory species of the longleaf forest in southern Monroe and western Escambia Counties were selected for their possible habitat indicator values. These were then rated for dominance in a variety of longleaf habitat situations. Height growth of the longleaf pine was taken as the standard measure of the habitat in each situation. Each indicator species was then related to height growth of the longleaf pine, due weight being given to the presence and dominance of the species in the various habitats. The indicator species were then arrayed in a moisture-regime list, from driest to wettest, using the species-longleaf height growth relationship as a guide.

The moisture-regime list of indicator species was tested for its ability to predict longleaf height growth in two new series of habitat situations. Predictions were highly accurate except where thick, droughty top-soils were combined with low slope gradients. In these exceptional situations, the moisture-regime scale of understory species significantly under-estimated height growth of the longleaf pine, thus indicating the failure of these species to reflect the soil moisture available to the deep-rooted pines.

Recent Developments in Forest Engineering

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Research engineers develop "hardware for tomorrow" from discoveries made today. Increased financial and other emphasis on research and development today is generating new discoveries in all fields of science at an astounding rate. The research engineer applies these new discoveries to many fields of the economy, including forestry. New scientific discoveries and techniques are being investigated for application in a total system to increase the efficiency and economy of all forestry operations. A few of these techniques are described and pictured in a slide presentation: (1) a site preparation and fertilization technique; (2) a pre-commercial thinning technique; (3) a mechanical technique for harvesting pulpwood; (4) helicopter logging techniques, and (5) pipeline techniques for collecting maple sap.

Processing and Storing Pollen of Southern Pines

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Since the southern pine breeder is interested in making controlled pollinations, it has become necessary to devise ways of collecting the desirable pollen, processing it, and storing it until the pollen is used.

The first step is to collect mature male strobili. Their maturity may be judged by observing when the strobili turn yellow or exude

a yellow paste when squeezed between the fingers. Strobili also may be collected when the first dehiscence of pollen is observed since not all strobili dehisce at the same time. Just before dehiscence, the strobilus scales open and the two pollen sacs are exposed.

When strobili are brought in, they should be washed to remove foreign pollen. They are then dried or placed in bags in thin layers so that molds do not infect them. Various extraction bags have been used. The two most commonly used are the Kraft bag with a screen holder inside and the sausage casing bag. The bag containing pollen is exposed to warm (72-80°F.), dry (20-40% relative humidity) air. The air is circulated around, and in some cases through, the bags. Four days are usually required before dehiscence is completed.

Pollen must be stored dry. Dry pollen has the characteristic of flowing like water and does not stick to glass. Pollen may be dried to this point by various methods if it is not already at the proper moisture content. One method is by vacuum desiccation. A newer method is by freeze-drying. This consists of placing the pollen under a vacuum of 50-250 mm, of mercury while it is frozen at a temperature of —50 to —60° C.

After drying, the pollen sample may be fractionated to eliminate dead pollen. This is done by placing the pollen in a glass tube that has a steady flow of air passing through it from top to bottom strong enough to blow dead pollen out but weak enough to allow viable pollen to remain in the tube.

Pollen may be stored in glass vials or tubes with cotton stoppers; or, if sample was freeze-dried, it may be stored in glass or metal tubes filled with nitrogen or kept under a vacuum. If the latter technique is used, the sealed containers may be left in uncontrolled conditions for at least two years, doubtless longer, with little loss of viability. If pollen is stored in cotton-stoppered vials, they should be placed in an atmosphere of 5-10° C. and 10-30% relative humidity. There it will keep well for two years.

Before use it is a good practice to test viability of stored pollen. This may be done by germinating pollen in distilled water or a non-pasteurized honey solution that has been incubated for 36-72 hours at 70-75° F. Pollen may also be germinated on a 0.7% agar—10% sucrose medium for 96 hours at 70-75° F.

The freeze-drying method and storage in air-tight, nitrogen-filled containers makes it possible to exchange germ plasm among different parts of the world. Thus, the need for maintaining exotic trees for their pollen is circumvented.

The Acceptance of Forest Management by Small Woodland Owners

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Small woodland owners realize that they are not giving sufficient attention to their woodlands. Age is undoubtedly an important factor, since one of the primary reasons mentioned for lack of forestry interest was "too long to wait." This is a valid reason for owners over sixty years of age, who represent nearly half of the non-managers.

Farmers are busy people. It is difficult to criticize them for not using all of their spare time in their woodlands if we recognize the general trend toward more leisure time, the periods of the year when farmers have no leisure time at all, and the effect this can have on the manner in which they use their time when work is slack. The reasons they state, "too much other farm work," is as valid from their standpoint as "too much work" often stated by professional people who still find time for fishing, golfing, and other leisure time pursuits.

"Need for available funds for other expenses" is always a good reason well worn by farmers and everyone else. Although it enjoys first and third preference by non-managers and managers, respectively, it is doubtful if the reason would hold if forestry assumed the importance of other farm practices in owners' minds. This is borne out by the evidence of funds used for farm and home equipment, conveniences, and wants in excess of actual needs.

The forestry information most needed is in the area of marketing. This is apparent from the study of their marketing practices. It also fits in with the opinion that a good timber sale is the most convincing educational method devised for increasing interest in forestry.

Non-managers studied have passed the awareness stage. They have attended meetings. They do not think forestry is too complicated. They do not lack information on how to proceed. They think it would pay. Owners' lagging interest, reduced by the long wait for returns, must be aroused to get results. Many are still in the interest and the evaluation stages. This indicates a need for increased effort in the area of mass media, but also points up the importance of the influence of neighbors and friends.

From the standpoint of the forester and the county agent engaged in informal forestry educational work, the course is obvious.

Greater emphasis must be placed on news articles, radio and TV, tours, field days, and similar approaches. They have another more potent approach, however, in local leaders. Non-managers who have passed the awareness and interest stages are influenced more by neighbors than by any other source of information. The local leader, or neighbor, is the best bet. From the data at hand, these two courses are indicated. They are the methods most likely to achieve success in overcoming the resistance of non-managers to the changes necessary for increasing their wood production.

Relation of Weather to Forest Fire Losses in Alabama—1963

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Alabama Division of Forestry

Forest fire losses in Alabama for 1963 were severe. Fire danger influenced by a combination of adverse weather factors was considered above the ten-year average during 7 of the 12 months. Peak periods of danger and loss were in April and October. Annual totals show an increase of 54 per cent in fire occurrence and 79 per cent in acreage loss.

The spring fire season was preceded by one of the coldest winters in the eastern half of the United States during the past century. Low temperatures killed considerable vegetation. In the late winter and early spring, upper-air circulation patterns produced stronger-than-normal west to east flows bringing waves of dry air from the Western United States. Statewide monthly rainfall deficiencies occurred from February through May. Fire losses averaged 89 per cent above the ten-year mean for the February-June period.

The fall fire season arrived with a drought already in progress. Rainfall reached a cumulative departure from the statewide average of minus 5.33 inches in October. Dry air masses moved into Alabama at regular intervals bringing low humidities and high winds. New fires occurred on 58 of the 61 days in September and October with a peak of 127 new fires reported on October 29. Acreage loss in October was 273 per cent above the ten-year average for that month.

Physics And Mathematics

Study of Radioactive Decay Schemes With a 2^{14} Channel Two-Dimensional Pulse Height Analyzer

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The development of a two-dimensional pulse height analyzer has made possible very rapid accumulation of concidence counting spectra, thus shortening materially the time required to examine a complex decay scheme. This paper describes the techniques employed to study the decay of I^{128}, In^{116}, and Ta^{182} by this method, with a discussion of the present degree of understanding of these nuclei. Techniques for preparation of I^{128} and In^{116} in the Auburn subcritical reactor are discussed. Previous work with these nuclei at Auburn University are reviewed, together with a discussion of the interest in these species. Spectra are shown, with a discussion of their significance for the decay schemes in question.

Space Travel and the Symmetry of Relativity

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The fallacies of popular thought regarding relativity, time dilation, and long space voyages are discussed. The approach is based primarily on the symmetry inherent in the assumptions on which relativity theory is based and the symmetry of the resulting equations. The Michaelson-Morley and Mossbauer experiments are reevaluated in terms of symmetry planes and a possible polydimensional approach.

A Linear Gate Circuit for a Multichannel Analyzer

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This paper results from undergraduate research participation in the summer of 1963. The design and development of a linear gate circuit for one microsecond pulses of 100 volts maximum amplitude is described. The circuit accepts pulses from two detector channels simultaneously on command from an external coincidence circuit and delivers them to two analog to digital converters at the input of a 2 dimensional pulse height analyzer. An additional feature of the circuit is its ability to reject pulses during the time the analyzer is processing a previous pair of pulses. Curves are shown illustrating the linearity of the gate, and the waveforms at various points of interest in the circuit.

Pulse Height Distribution in Cerenkov Detectors

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This study of the pulse height distribution in large, diffusely-reflecting, water-filled Cerenkov detectors due to cosmic ray particles has been undertaken to improve the understanding of the efficiency of these detectors in preparation for their use in cosmic ray experiments. Three such detectors are operated in coincidence to form a cosmic ray telescope. The spectrum of coincident pulse pairs in two of the three detectors has been examined with a 2^{14} channel two-dimensional pulse height analyzer, making possible elaborate study of the pulse distribution. Curves are presented, and an explanation of the shape of the spectrum observed is offered in terms of the statistics of the light collection and photoconversion processes.

Multiple Regression Analysis in Medical Research

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Multiple regression analysis (MRA) is a method to obtain the best fit of a set of observations of independent and dependent variables. The results of such analysis are particularly useful in medicine, since the complicated body systems do not readily lend themselves to isolation for study as independent units. A typical example of the use of MRA is demonstrated by the kinetocardiogram (KCG), which is chest wall displacement due to heart beat. Using points of the KCG as independent variables and mean pulmonary artery pressure as a dependent variable, MRA gave an equation that predicted 65 per cent of the variance for nine patients.

A Carbon-14 Dating Laboratory

James Lynn Smith
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A laboratory is under development to do carbon-14 dating, employing the recently perfected method of converting the sample to Co^2 gas which is used as both sample and counting gas in a proportional counter. The design of a counter, and an anticoincidence shield counter is described, and their performance discussed. The chemical preparation of the Co^2 gas is described, with comments on the problems of purification. The long-range purpose of this development is discussed, including the intention to date archeolgical finds and to pursue problems in geophysics. A discussion of the electronic circuits necessary to operate the laboratory is included.

The Cambridge Conference Report on School Mathematics

W. L. Furman, S.J.

The Report of the Cambridge Conference on School Mathematics set forth a proposed curriculum from kindergarten through the twelfth grade. It is recognized that the responsibility for keeping mathematical education vital and up to date belongs to mathematiciand in universities, schools, and industry. The board goals proposed would give the student finishing high school the equivalent of three years of present college mathematics. Some problems arising from the recommendations of this conference are the ability of elementary school childrn to learn certain abstract concepts of mathematics, the resources of the schools to put in to effect the revised curriculum, the training of teachers, the development of valid tests for the measurement of achievement, and the reorganization of the college curriculum.

The New Recommendations for College Physics Curricula

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Spring Hill College

The Commission on College Physics, with the support of NSF, conducted three nation-wide conferences for the purpose of making recommendations to the colleges and universities on curricula for

undergraduate physics majors. The resulting recommendations are that two different curricula, called "R" and "S," be recognized as standards for college courses. A summary of these curricula is given. Comments and criticisms are posed. The conferences on curricula will have gone a long way toward improving college physics teaching if they stimulate a vigorous discussion by educators and physicists.

Electrical Conductivity of Plasms in Uniform Electric Fields

Tsun-hsiung Kao

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The electrical conductivity of a nitrogen plasma has been measured in the region of a parallel electric field. The plasma is generated using a dc potential applied between two parallel plate disc electrodes two inches in diameter. Each electrode is symmetrically located in the center of a flat ring six inches in diameter. The radial separation between the disc and ring is less than 0.010″. The ring and disc are maintained at the same potential, producing a guard ring configuration which results in a very nearly parallel electric field between the two central discs. The vacuum chamber is aluminum, thereby eliminating electrostatic building which could distort the field. The chamber is sufficiently large that the distance from electrodes to chamber walls is large compared with the electrode separation or size.

Data has been taken over the pressure range of 100 to 1000 microns. Values of the current density have been computed from the central electrode current as a function of pressure using the relation:

$$\underline{J} = \sigma \underline{E}$$

where the electric field is assumed to be uniform as well as parallel. Justification for this approximation will be shown. Values of the current density at field strength of 600 volts/inch have been fitted to a curve of the form

$$P = a\sigma^2 + b\sigma + c$$

The observation of an anomalous current variation in the central electrodes will be discussed.

Preliminary Results on Radial Dependence of Current Density in a Highly Ionized Plasma With Cylindrical Symmetry

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Preliminary studies have been carried out on the radial distribution of the current in acylindrically symmetric electrical discharge in nitrogen. Data have been taken over the pressure range from 100 to 1000 microns using parallel plate disc electrodes. Each electrode consists of a central disc two inches in diameter, symmetrically centered in a flat ring, six inches in diameter. The radial separation between the disc and ring is less than 0.010″. The currents through both the ring and the central electrode are measured individually. The vacuum system containing the discharge is constructed of aluminum in order to prevent electrostatic buildup on the chamber walls which might influence the discharge. In addition the geometry of the vacuum chamber is such that the distance between the electrodes and the walls is large when compared with the electrode size and separation.

All data taken have definitely shown that the current density possesses a radial dependence. The average current density through the ring is always greater than the average current density through the central disc. The ratios of the current densities have been observed to vary from two to eight, depending on gas pressure, electrode separation, and applied voltage. Further work in progress should yield well-defined radial dependence.

Industry And Economics

Outdoor Recreation—An Opportunity for Alabama

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Outdoor recreation offers a real opportunity for increasing incomes and levels of living for many Alabama families. It is one "crop" that does not have an overproduction problem. However, it is not a "cure-all" for the problems of low income and overproduction in agriculture. It can contribute to the solution of both.

To get some idea as to exactly what our potential may be for developing this industry, some of the major factors that influence the demand for outdoor recreation should be examined.

The 1960 U.S. population of 179.3 million is expected to increase to about 230 million by 1976 and to over 350 million by 2000. By assuming no increase in the rate of participation, population alone would double the demand for outdoor recreation in less than 40 years. Other factors, however, point toward an increased rate of participation. Disposal consumer income in 1960 was $354 billion. It is expected to reach $706 billion by 1976, almost double the 1960 level, and to increase to $1,437 billion by 2000. Although the cost of living will increase, our incomes are expected to increase considerably faster, giving us more money for recreation.

Increased leisure time will also increase the demand for outdoor recreation. The Bureau of Labor Statistics estimates the present work week of 39 hours will be reduced to 36 hours by 1976 and to 32 hours by 2000. Also, a factor in leisure time is the weeks of paid vacation leave acquired each year. It is expected to increase from the present 2 weeks per year to 2.8 by 1976 and to 3.9 by 2000.

Intercity auto travel, also a factor in demand for recreation, is expected to increase from 670 billion passenger miles in 1960 to 1,400 billion in 1976 and to double the 1976 level by 2000.

These five major factors, as well as other less important ones, are expected to triple the demand for outdoor recreation in the next 40 years.

Although these trends have been for the U.S. as a whole, I expect similar trends for Alabama. We should also experience a tripling in our present demand for outdoor recreation by the turn of the century. The Bureau of Outdoor Recreation has estimated that Alabama's travel expenditure will more than double by 1976, reaching a figure of almost $561 million as compared to the 1961 figure of $270 million. The receipts of commercial recreation establishments in Alabama almost tripled between 1948 and 1961. Other indices, such as number of hunting and fishing licenses, also indicate rapid growth in our recreation industry. Also, as more facilities are developed thus improving the opportunities, participation will increase more rapidly.

Alabama's present recreation industry, except for hunting, is heavily water-oriented. Four areas in Alabama that are of major importance include: (1) the TVA reservoirs in North Alabama; (2) the impounded lakes along the Coosa River; (3) Lake Martin in Tallapoosa County, and (4) the Gulf coast areas southeast of Mobile.

Also important to Alabama's recreation activity are the state parks and public lakes. Between October 1, 1961, and September 30, 1962, over 3 million attendances were reported. Over 280,000 of these were out-of-state visitors.

No doubt these types of public facilities will continue to be important, but publicly supported recreation facilities cannot keep up with the increased demand that is expected. If the demand is met, it must come from development of both public and private facilities.

A number of people have already realized this potential and have developed facilities. At least two quail preserves have been established in Alabama in recent years. In Limestone County, farmers are increasing their incomes by building duck blinds in areas where ducks and geese come in for feed and water. Several persons have started summer camps for children.

An elaborate development can be found in Clay County where an owner has built a 125 acre lake for fishing and skiing. He has sold 45 lots around the lake for home and cottage sites and twenty-five homes have been constructed. The owner expects to regain his total investment within 5 years.

One interesting facility in Chambers County exhibits what can be done with limited capital, a little ingenuity, and a lot of hard work. The owner, once a Grade A dairy farmer, has now converted his pastures into a golf course, built five fishing lakes, and converted much of his old farm machinery into rides for children.

Other possibilities would include private golf courses, farm vacations, scenic walks, tours, etc. One's imagination is possibly the most limiting factor.

Two large development areas that are expected to develop more rapidly than most others in the state, with the possible exception of the Tennessee River system, are Lake Logan Martin in Calhoun, St. Clair, and Talladega Counties and Lake Smith in Cullman, Walker, and Winston Counties. These areas are in a highly populated area of the state and feasibility studies have already been completed.

The purpose of this paper was to provide some insight into the present situation and the potentials that exist for improving the state's economy through the expansion of a relatively new industry—outdoor recreation.

Prosperity Without Inflation?

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Inflation is one of the major unsolved economic problems of our time. For almost two decades, the United States has enjoyed a high degree of prosperity. People are better housed, better fed, and better clothed than ever before. Our economy is highly productive and despite minor recessions there is small chance that the nation will suffer a major depression. According to one group of economists, however, we have not yet learned how to control inflation.

During recent years, the relationship between inflation and prosperity of the country has been explored to great depths. Many economists have stated that we must have inflation of some type in order to be prosperous. Others have indicated that we can have prosperity and growth in the economy and still have stable prices. A third group, however, is uncertain as to the relationship between prosperity and the price level. This paper represents an effort to bring these divergent views into a meaningful perspective.

The Communist Blueprint and the Downfall of China

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The Communist plan of aggression has been reported extensively in Communist literature. The downfall of the Chinese mainland to the Communists emphasizes the effectiveness of their plan. This paper includes an analysis of the aspects of the Communist plan of world domination using China as a case study. The writings of Chiang Kai-shek in his book, *Soviet Russia in China*, are used as the major focal point in gaining additional insights.

The paper is divided into four sections—Introduction, The Communist Take-over in China, Lessons to be Learned, and Conclusion. In the Introduction, the Communist Blueprint for World Conquest is outlined, and Chiang Kai-shek's plea to the Free World not to ignore the lessons that should be learned from the Communist take-over in China is sounded; the second section traces the historical events from 1885 to 1946 which resulted in the fall of China and the take-over by the Communists; the third section points out the lessons which the Free World should learn from the experiences of the Chinese and Cubans—that the Communists are constantly mobilized and waging war, either hot or cold, and that their activities fit into their Blueprint for World Conquest, which includes: (a) peaceful coexistence with the existing political and economic system in a country, this coexistence being characterized by political infiltration and sabotage; (b) an agrarian revolt designed to deliberately create animosity between the rich and the poor; and (c) taking over complete control and occupation of the country through force and murder.

The last section is centered around Chiang Kai-shek's plea for the Free World to initiate positive and all-inclusive strategy against Communism. Neutrality is entirely insufficient. Neutrality is virtually the same as giving direct assistance to Communism. To the Communits, neutrality acts positively as a forward base in their war against freedom, and negatively as a shield for the protection of Communism itself. A positive, all-inclusive program must, therefore, replace neutrality. Anything less would be ignoring the lessons that the Free World should have learned from the tragedies in China and Cuba.

Agricultural Economics in Southern Land-Grant Institutions: Enrollment and Employment Opportunities of Graduates

Lowell E. Wilson
Department of Agricultural Economics, Auburn University

Modern agriculture has become a complex industry requiring many well-trained agricultural personnel. Much of the responsibility to train people for agricultural careers rests with schools of agriculture and departments of agricultural economics. As a basis for determining the role that agricultural economics is playing in providing trained agricultural people and employment opportunities for such graduates, all agricultural economics departments in the southern region were requested to provide data relative to their programs.

Increasing enrollment in southern land-grant institutions has been largely in areas outside the colleges of agriculture. During the past decade, enrollment in colleges of agriculture declined substantially in total numbers and as a percentage of total enrollment in the southern land-grant institutions. Despite decreasing enrollment in agriculture, the field of agricultural economics has enrolled an increasing percentage of undergraduates in agriculture.

Enrollment in agricultural economics both at the undergraduate and graduate levels has increased substantially in the past few years. Based on junior and senior student enrollments, the number of undergraduates in agricultural economics in the southern institutions increased more than 60 per cent since 1955. Graduate enrollment increased more than 300 per cent during the same period. If the present level of graduate enrollment continues, the departments of agricultural economics in these institutions will be graduating considerably more than 100 students with graduate degrees per year. Of this number about one-third will receive Ph.D. degrees. Most departments expect a continued increase in undergraduate and graduate enrollment.

Objectives of students majoring in agricultural economics vary widely. Surveys of graduates show that a large percentage of students holding the Bachelor's degree as a terminal degree are employed in agribusiness occupations. Most departments in the southern institutions are placing increased emphasis on training students for agribusiness employment.

Income data obtained from surveys of agricultural economics graduates were available from Auburn University and North Carolina State. Of 211 bachelor of science graduates, about one-third had annual incomes in excess of $10,000 and about 50 per cent of the graduates had incomes in excess of $8,000 per year.

A large percentage of graduate degree holders is being employed by public agencies. With anticipated increase in the number of master's and Ph.D. graduates, competition will increase considerably for positions available in the present areas where graduates first find employment. It is expected that more students receiving graduate degrees in agricultural economics will seek employment with private industry. In addition to the growing need for developing programs to help graduates find satisfactory employment, most departments will need to adjust their graduate training programs to prepare students for a wide range of economic and social problems relating to agriculture.

Social Sciences

The First Muscle Shoals Project, 1783-1798

Adrian G. Daniel
Troy State College

Significantly, the beginning of the first Muscle Shoals project occurred in the same year that the Treaty of Paris granted independence to the United States and extended its domain westward to the Mississippi River. In 1783 an enterprising group of Virginians and North Carolinians organized the Muscle Shoals Company for the purpose of establishing the first permanent American colony at Muscle Shoals. At the same time the group envisioned the construction of a canal between the Tennessee and Tombigbee Rivers via Bear Creek, in order to connect the Ohio River with the Gulf of Mexico at Mobile and make Muscle Shoals the financial and commercial capitol of the lower Ohio and Mississippi Valleys.

The group of speculators for this ambitious project consisted of some of the foremost pioneers of the Old Southwest. The principal leaders were Governor William Blount of the Southwest Territory, Colonel John Sevier, Colonel John Donelson who was the father-in-law of Andrew Jackson, Colonel Joseph Martin, Revolutionary War patriot Patrick Henry of Virginia, and Zachariah Cox and Lachlan McIntosh, Jr., of Georgia. Four other noted individuals connected with the giant project included Wade Hampton of South Carolina, who was the grandfather of the Confederate general of the same name; Robert Morris of Philadelphia, financier of the American Revolution; Swiss-born Albert Gallatin of Pennsylvania; and the Creek Indian chieftain, Alexander McGillivray.

The Muscle Shoals project also became an integral part of the independent State of Franklin in East Tennessee. It was also involved in Spanish intrigue and the Yazoo land schemes through the Tennessee Yazoo Company.

In addition to settlement, the plans included construction of a canal between the Tennessee and Tombigbee Rivers. Every effort, however, to develop the project, including settlement, was thwarted by the federal authorities, even to the extent of the use of the U.S. Army. With the organization of the Southwest Territory in 1798 (present-day states of Kentucky, Tennessee, Mississippi, and Alabama), the project was temporarily abandoned.

Upon the election of Thomas Jefferson to the presidency in 1800 and his appointment of James Madison as Secretary of State, settlement of the region was encouraged and shortly thereafter dreams of a Tennessee-Tombigbee canal were revived. Thus, settlers in the Huntsville area rewarded Madison for his encouragement and assistance by naming the county in his honor.

Low-Income Rural Households and Prospects for Adjustment

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Since the beginning of the 20th Century, leading Americans have been concerned with the problem of low-income and its correlate—poverty. Attempts have been made to improve the situation by making available better social and economic opportunities within these areas. In spite of these efforts, the problem has continued to linger in some areas, particularly in rural areas of the South. It is now generally recognized that the low-income, rural problem is unique and demands new and imaginative solutions.

The Southern Regional Project in Rural Sociology is concerned with the prospects for adjustment among households in low-income, rural areas. In order to ascertain more clearly these prospects, survey data were gathered throughout the region on the social, economic, human, and social-psychological aspects of the people. The results of this study suggest that prospects for these households to improve their social and economic condition are very poor without assistance from agencies outside these rural areas. However, it was not found that these households lacked a favorable attitudinal orientation toward change. The primary deterrent to their adjustment prospects was not their attitudes and lack of occupational aspiration, but rather, in their low-level education, advanced age, and lack of surplus capital for investment.

The Role of New Orleans in Mexican Filibustering, 1835

Raymond Estep
Air University, Montgomery, Alabama

New Orleans, with its long history of French and Spanish rule and its nearness to Spanish colonies surrounding the Gulf of Mexico and the Caribbean, became a natural recruiting ground to which flocked independence-minded Spanish colonials and, in a later era, exiled citizens of the youthful Spanish American republics. In the Crescent City they found bankers, merchants, and others willing to finance their plans for the conquest of power and of empire.

During the summer and autumn of 1834 an internal crisis aligned Centralist against Federalist in a struggle for control of Mexico. In the end, the Centralists, led by the turncoat Federalist, President Antonio Lopez de Santa Anna, triumphed over the forces led by Colonel Jose Antonio Mexia. Exiled to New Orleans in the autumn of 1834, Mexia, during the following year, laid the groundwork of a plan for the return to power of the Federalists. Here he was visited by Lorenzo de Zavala, one of Mexico's more astute Federalists, in July 1835, and here he was joined by another exiled Federalist, Vice President Valentin Gomez Farias, in September of the same year. In the meantime, the first engagements of what was to become the Texas Revolution stimulated the residents of New Orleans to furnish material support for the Anglo-Saxon settlers to Texas. In the process they also gave their aid and encouragement to the plan conceived by Mexia and Gomez Farias for capturing Tampico and winning all northern Mexico for the Federalists. They assisted Mexia in purchasing a sailing vessel, in manning it with a crew, in stocking it with munitions of war, and in enlisting a force of about 150 men. The expeditionary force they helped to create suffered an ignominious shipwreck in attempting to land at the mouth of the Panuco River and a more disheartening defeat in a night assault on the city and garrison of Tampico. Rescued by a U.S. sailing vessel, the filibusters returned to New Orleans by way of Texas where a few enlisted in the Texas Army. Mexia was later indicted in New Orleans by a Federal grand jury, but, either through the intervention of powerful friends or because of the lack of evidence, was never brought to trial. He continued to make New Orleans his home until the summer of 1838 when he was captured and executed while leading another expedition against Santa Anna.

The Knights of St. John as a Naval Power in the Mediterranean

Bernerd Clarke Weber
History Department, University of Alabama

The Knights Hospitaller of St. John became a great militant monastic Order which originated during the period of the Crusaders, and which carried on a vigorous struggle against the forces of Islam. Following the loss of their holdings in the Holy Land in

1291, the Knights moved first to Cyprus and from thence to Rhodes. On this island stronghold they developed their naval power and became a major factor in the political rivalries in the Near East during the 14th to the 16th Centuries. After the loss of Rhodes, the Knights Hospitaller eventually became established in the Maltese archipelago in the middle of the Mediterranean area. From this vantage point, the Order continued its naval warfare against the Mohammedans. Christian Europe found in the Knights of St. John one of its most important defenders. The Knights performed a valuable task in keeping open the sea lanes. Also, the navy of the Order provided first-rate training for a number of potential officers in the navies of Christian powers. The significant activities of the Knights in this area continued until 1798 at which time they were expelled from the Maltese archipelago by General Napoleon Bonaparte, then on the way to his historic expedition to Egypt.

Four Years with the Coast Survey: A Chapter in the Life of a Nineteenth Century Naval Officer

Robert E. Johnson
History Department, University of Alabama

Lieutenant John Rodgers of the United States Navy was ordered to duty with the Coast Survey in 1849. The Survey, headed by Alexander D. Bache, was dependent on the Navy for officers to command its vessels which usually had been discarded by one of the military services and so were not well fitted for their duties. However, most junior naval officers sought such an assignment, for it offered independent command and shore duty in Washington during the inclement season. Rodgers was placed in charge of Section VI (the east coast of Florida) and commanded the small schooner *Petrel* for a few weeks until the former Army sidewheel steamer *Hetzel* was turned over to him.

While surveying of Cape Canaveral in February 1850, *Hetzel* had the misfortune to be driven ashore when her anchor chain parted. It seemed very doubtful that she could be salvaged, but after two weeks of arduous labor the steamer was refloated, only to be beached again when she leaked so badly as to be in danger of sinking. She was recaulked well enough to reach Indian River Inlet for further caulking and then steamed to New Orleans for repairs while Rodgers continued an earlier survey of the Key West vicinity in *Petrel.*

Hetzel continued on the Florida survey in 1851, during which time Rodgers' attempt to take a cross-section of the Gulf Stream between Key West and Cuba was frustrated by the parting of the deep sea lead line and his efforts to devise a method for measuring submarine currents were equally unsuccessful. However, he did develop a type of small boat which proved useful for work in very shallow water.

Since *Hetzel* had proven herself a poor sea boat, Rodgers took the iron screw steam *Legare* for the 1852 season. Bad weather and his vessel's deep draught hampered the surveying parties in that year; nonetheless creditable progress had been made by the season's end. Lieutenant Rodgers was then ordered to join the Navy's North Pacific Surveying Expedition as second-in-command, succeeding to the command when his senior fell ill a year later. Much of the success of this expedition was undoubtedly due to Rodgers' Coast Survey experience.

Oratory as American Cultural Document

Clarence C. Mondale

History Department, University of Alabama

For a determinant period in New England culture (say from 1810 to 1835), the orator was considered to represent high culture and eloquence, the consummate art. A study of New England ceremonial oratory reveals that certain values were implicit in the ideal of the orator: a liberal education, a concern to bring that education to bear upon public deportment and policy, an assumption that the culture was knit together by a system of public ideals to which the orator gave expression. Along with the ideal of the orator went the characteristic oratorical style, designedly dignified above the level of everyday speech. In the 1810-1835 period, oratorical value and style took on a characteristically American expression: a dignified speech gives voice to the plain values of the early republic. By 1850 the ideal of the orator had lost its old authority. The style of the public performers became miscellaneous and eclectic, and public value became fragmented. These conditions were at least partly responsible for the startling flowering of New England literature which occurred at that time.

Book Review Section

THE ALABAMA CONFEDERATE READER, Malcolm C. McMillan (ed.). University of Alabama Press, 1963. xxii + 468 pp. $7.75.

Here is a book of documents, well chosen and well edited, that holds the reader's interest from start to finish. The momentous developments of the Civil War as they affected Alabama and Alabama people are pictured in the vivid words of participants and observers. Great events of state and intimate human details are mixed together in such proportion as to give the reader a sense of closeness to and identity with the matters described. Facts and interpretations added by the editor at appropriate places make otherwise disconnected documents hang together in what seems almost like a continuous narrative. The reader can dip in at any point he desires, however. The book is hard for an Alabamian to put down, once he has started to read it.

Chapter titles indicate the range of subject matter: "The Gathering Storm," "The Secession Convention," "Alabama Withdraws from Congress," "Montgomery: Cradle of the Confederacy," "War Begins," "King Cotton Diplomacy," "The First Battle of Bull Run," "The Battle of Shiloh," "The War in North Alabama," "Colonel Streight's Raid," "The Tide Turns Against the South," "Politics in Alabama During the War," "Rousseau's Raid and Sherman's Georgia Campaign," "Confederate Ordnance and Supply," "Alabama Fights on Inland and Outlying Waters," "Behind the Lines: Home Front," "Efforts for Peace and Peace Societies," and finally "The Fall of the Confederacy."

There is no need for one to be a history specialist to read and understand this book. The editor anticipates the questions of the reader and answers most of them quite fully. The numerous illustrations are helpful, too. Professor McMillan, who is head of the Department of History at Auburn University, and the University of Alabama Press are both to be congratulated on a fine job.

—James F. Doster, University of Alabama

INSTRUCTIONS FOR CONTRIBUTORS

Editorial Policy:

Papers to be considered for publication in the *Journal of the Alabama Academy of Science* may be submitted by either Academy or non-Academy members at any time during the year. Publication priority, however, will be given to material submitted by members of the Academy. All papers will be judged by a review board on the basis of the materials presented and the interpretation or analysis made of these materials.

Abstracts of any annual meeting papers not to be published as a complete paper in the *Journal* should be given to the appropriate section chairmen by the close of the annual Academy meetings. These abstracts will be reviewed and processed by the Editor in a manner similar to established procedures for complete papers.

Any major professional work under Alabama authorship should be called to the attention of the Editor in the interest of obtaining an appropriate review of the work for the Book Review Section of the *Journal*.

Manuscripts:

Manuscripts should be typed double-spaced, allowing good margins. An original and one copy should be submitted to the Editor. Captions and legends for figures should be typed on sheets separate from the text. The list of cited literature should also be typed double-spaced on sheets separate from the text. The title of the paper should be as short as is consistent with clarity. Primary divisions may be indicated by central headings and subdivisions by italicized captions at the margin. Conventional professional form relative to quality of expression, tense, person, etc., should be employed. Abstracts of papers should not exceed 200 words and should not include illustrated materials or footnotes except where absolutely necessary.

Figures and Tables:

All figures and tables should be numbered consecutively with legends included. Illustrations (including tables) should be planned to occupy the entire width of a page (4½ inches), and any portion of the height (7 inches). Original photographs should be submitted as clear black and white prints on glossy paper; these should not be bent or folded, and paper clips should not be used.

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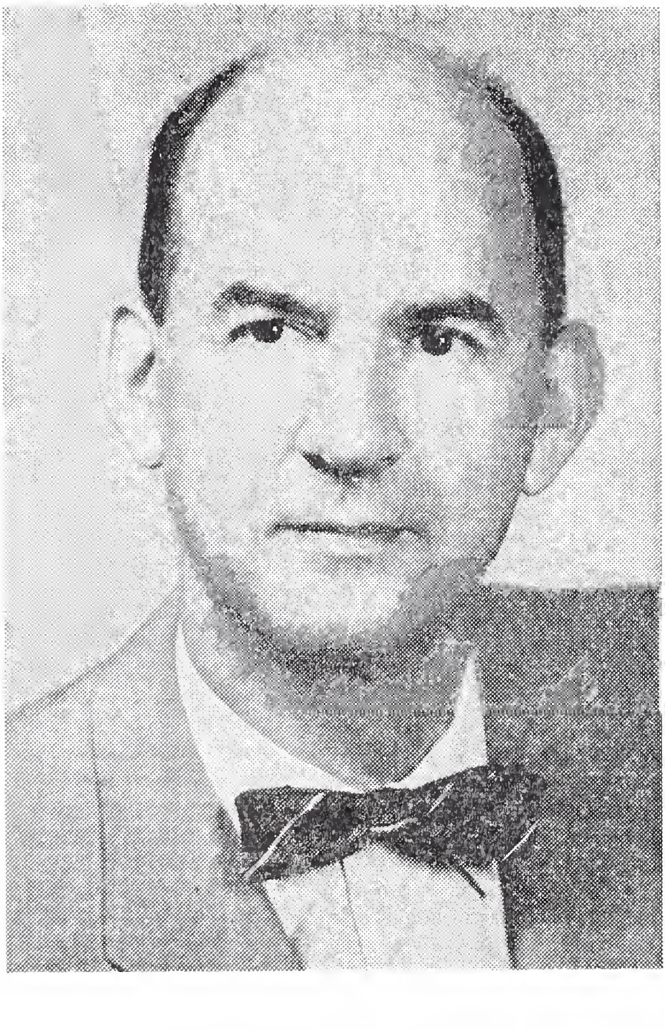

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PRESIDENTIAL ADDRESS

The Impact of Instruments on Research

William J. Barrett
Southern Research Institute

At the 1965 Academy meeting, we have scheduled 24 separate technical sessions and about 125 papers. The sections comprising the physical and biological sciences have about 55 papers. Scanning the titles of these 55 papers, I see that 14 are concerned in a major way with an analytical instrument. Eighteen titles suggest that one or more analytical instruments were used in the work described. Thus, about 60% of the papers in areas that could conceivably use analytical instrumentation actually do so. Those that do not are in such areas as botany, zoology, and science education. Whether or not they are directly concerned with instruments, most of the participants in our program rely to some degree on information obtained by means of laboratory instruments. It is also noteworthy that some of the student exhibits on display at this meeting are concerned with measuring properties of materials, and some are quite sophisticated instruments.

In the past ten years, we have seen a veritable avalanche of complex and expensive new research tools. These tools include such diverse items as analytical instruments, computers, and space-environmental chambers. They are revolutionizing the research business in many ways. Perhaps their most important aspect is that they allow the researcher to obtain technical information that he would otherwise have to get along without. For example, many scientific problems were shelved for years because necessary mathematical computations were beyond the scope of an ordinary human's capabilities. Computers can reduce a lifetime of arithmetic to a few seconds of solid-state switching. Many kinds of scientific data that yesterday just weren't obtainable by any means, are today automatically recorded in digital form or on fast-moving chart paper or magnetic tape. All of these new instrumental developments are having a dramatic impact on the scientific literature, on the training of scientists, on the amount of research that can be accomplished by one man, on the management of laboratories, and on the sector of industry that manufactures these tools.

Instruments and electrical or mechanical devices are by no means the only important tools of research. We must acknowledge that a good human brain still has some advantages over machines. Someone has remarked that man is still the best 150-lb. computer and, moreover, is produced by unskilled and unpaid labor.

Some of us might say that money is the foremost tool of research. After all, how is it possible in 1965 to undertake a research project without a Federal grant or contract? Research and development is a $15-billion business. These funds are providing laboratory buildings, salaries, and facilities for literature searching, and an increasing proportion is going for instruments and other laboratory equipment.

The concepts and origins of analytical instruments are found in many scientific disciplines. In the 1920's Jaroslav Heyrovsky in Prague was studying the properties of mercury electrodes. In order to measure the physical phenomena that interested him, he found it necessary to devise a new kind of electrode—a flowing mercury electrode. As frequently happens in research, Heyrovsky soon observed phenomena that he had not anticipated. Being a perceptive scientist, he recognized the potential value of a flowing-liquid-metal electrode as a research tool, and eventually as an analytical tool. Most of us know that the Polarograph has become one of the most useful and versatile analytical instruments. In recognition of his accomplishments, Heyrovsky received the Nobel Prize in Chemistry in 1959.

A need for a new way to solve a specific research problem sometimes leads to a technique or analytical instrument of general application. Heyrovsky's Polarograph illustrates that statement. Fundamental studies of the magnetic properties of atomic nuclei resulted in a Nobel Prize for Bloch and Purcell in 1952. The research equipment used by them developed within a few years into commercial nuclear magnetic resonance spectrometers. In 1965, a laboratory doing organic chemistry is ill-equipped if it doesn't have an NMR spectrometer.

The adaptation of new fundamental discoveries to commercial equipment comes a little faster than it used to. In 1961, Mossbauer received a Nobel Prize for his discovery of the recoilless resonance absorption of gamma rays in atomic nuclei. In 1963, you could buy a commercial Mossbauer-effect analyzer.

Biomedical investigators, whose research problems are among the most difficult, have made some of the most significant contributions to instrumentation. It is rather impressive to hear an M. D. who is doing medical research discuss knowledgeably such diverse areas as hydrodynamics, electronics, and biochemistry, all in relation to one research problem. Some commercial bioanalytical instruments carry the name of the original developer who designed and built the instrument in his own laboratory to meet his own needs. One such is a fluorometer, designed by Dr. Robert Bowman of the National Institutes of Health and manufactured by the American Instrument Company and called the Aminco-Bowman spectrophotofluorometer.

Instrument manufacturers have problems peculiar to their industry. Most are relatively small companies, doing 10- to 40-million dollars of business annually. They do little research themselves; instead, they depend on fundamental discoveries made in academic, industrial, and government laboratories to suggest new instruments. However, the cost of development—of adapting the basic design to a salable product—can be tremendous. This cost is, of course, reflected in the price the user has to pay. Development costs are increasing, too, because the user is demanding greater sophistication and versatility. These demands are based on the sound principle that research productivity must keep up with manufacturing productivity. Besides building instruments with eye-catching gimmick features, the manufacturer has to provide customer training for many of his products. Nearly always, the quality of service rendered during the life of the instrument is an important factor in competition from other manufacturers. These services are expensive.

The increasing use of instruments in the last decade has created curriculum problems for the science faculties of colleges and universities. There is at present some degree of controversy among chemistry and physics instructors as to how much instrumentation should be included in course work. Some instructors are advocating the inclusion of instrumentation in all or most courses to the degree appropriate to the main content of the course. Others prefer to stick to the more common practice of providing a course in instrumental analysis. Although they are careful to emphasize that training in the sciences must cover fundamental and theoretical principles, most instructors recognize the advantages of using instruments in laboratory experiments. With instruments, experiments are neater and cleaner, they require less time than classical experiments, accuracy and precision are better, and the student has more time to study and interpret the data he gets. The experiments become less descriptive and more quantitative; the fit of the data to theory is better; and sometimes the student can obtain a sense of satisfaction in rather easily verifying the predictions of theory.

We need to provide instrumentation training for three kinds of people: the instrument specialist, who understands the basic principle and who can apply almost any optical, mechanical, or electronic technique to the design, operation, and use of the instrument; the instrument operator, who knows how to prepare the samples and turn the knobs to produce acceptable data; and the instrument user, who must be prepared to interpret the data and apply it to the solution of his research or production problem. The instrument specialist obviously requires advanced training and he could easily use a Ph.D. in physics and one in chemistry and one in biology and one in electrical engineering. The instrument operator may be a technician. The new junior colleges that are arising everywhere should be prepared to train people for these jobs. The instrument user may, for example, be an organic chemist with a molecular structure problem, or a manufacturer monitoring a production process, or a space engineer planning to analyze the moon's surface. The variety is limitless.

Laboratory managers have their problems, too, and the main one is cost. Everything scientific seems to ride on a steeply rising curve. The number of scientific publications, the number of scientists at work, the number of dollars expended, and perhaps even the number of worthwhile new scientific discoveries—all of these are doubling every few years. The number of new instruments, their complexity, and their costs are not exceptions. Managers with conservative inclinations must wonder if all of this fancy gadgetry is really necessary. And it may be a debatable point, especially at budget reviewing time. The kind of question that may arise is this: Should we invest $20,000 in an instrument that is necessary to do 10% of the research in a $100,000 project?

Consider the specific costs of a few fundamental analytical instruments. If you want to provide the absolute minimum for these five kinds of instruments: NMR spectrometer, mass spectrometer, electron microscope, electron probe analyzer, and x-ray spectrometer, you must spend at least $200,000. To gain some versatility in the utilization of these instruments, one could easily spend $500,000. These amounts would not upset a Government agency, but they are large sums in a college budget or that of a medium-sized industrial research laboratory.

Having acquired these complex and wonderful machines, the user then faces the problem of keeping them working. This could cost more than he paid for them initially; but we must agree that most instruments are well designed, made of quality components, and backed by a good service warranty. In a few instances, haste to get into the market has caused a manufacturer to have to withdraw a poorly designed instrument that was offered too soon. A well-equipped laboratory needs its own service engineer, one who knows electronics, optics, and mechanics.

Obsolescence of instruments is as real, if not as deliberate, as the obsolescence of automobiles. Electronic components do deteriorate. New developments in instrumentation frequently produce such improvements in performance and capability that one just can't afford to keep on using the old spectrometer. The Perkin-Elmer Model 21 infrared spectrophotometer came out about 15 years ago, and gave tremendous impetus to molecular spectroscopy. But it was supplanted after several years by the Model 221, then in about three more years by the Model 421; and after two more years the Model 521 appeared. A few weeks back the Model 621 was announced, and next year there will, no doubt, be a 721.

The ultimate criterion of value of an instrument is its capability. One should weigh cost against accomplishments. To illustrate the remarkable capabilities of some of the newer analytical tools, let us consider a few examples.

Gas chromatography was born in 1952. In 1962 it was referred to as the "King of Chemical Analysis." No other analytical technique has ever grown so rapidly, whether measured by variety of applications, number of users, number of papers published, or rate of sales of commercial instruments. The reasons for its success lie in the relative simplicity of the apparatus and technique, the capability of separating complex mixtures impossible to separate by other means, the high degree of sensitivity, and wide scope of application. One milligram of a mixture of thirty hydrocarbons in gasoline can be easily separated into the individual components, and in a matter of minutes. That rather astonishing capability has been a bonanza to researchers in chemical and biomedical fields.

In the electron microprobe analyzer, a finely focused beam of electrons impinges on a sample surface and generates x-rays whose frequencies are characteristic of the elements present. Three features of the microprobe make it unique. It can analyze a sample only one cubic micron in volume. Determinations can be made of every element in the periodic table except the four lightest—hydrogen, helium, lithium, and beryllium. It is non-destructive. The electron microprobe does not involve any newly discovered phenomena, but it represents a remarkable advance in conquering the technical problems of complex instrument design.

Activation analysis is a by-product of the nuclear age. When an atomic nucleus is bombarded with neutrons or energetic charged particles, new radioactive isotopes may be formed. Measurement of the induced radioactivity permits qualitative and quantitative estimation of the elements present in the sample. Since activation analysis is a nuclear method, it is independent of the chemical form or valence state of the elements. For more than half the elements in the periodic table, activation analysis is the most sensitive method known. Detection limits are as low as 10^{-13} grams—only about 10^9 atoms, a small amount indeed.

If instrumentation has grown so rapidly in the last 15 years, where will tomorrow's developments lead us? A prediction is as hard to make for this field as for any area of science. Although we may not successfully forecast new basic principles, we can see the direction in which some present trends are leading. The expansion of scientific research in general will require a faster rate of accumulation of data. This means a continuing increased use of automation. No longer will we be able to afford a day's labor for the analysis of one sample. Instead, the automatic analyzer will perform many analyses where the analyst did only one before. With the increase in automation and rate of output of data, the pencil and notebook will no longer be adequate for recording results. There will be a major increase in the use of computers to calculate the final results of instrument measurements. Results will be printed or recorded on magnetic or punched tape.

I am speaking as though these are to be developments of the future. They are already here. You can buy an analyzer for carbon, hydrogen, and nitrogen that handles sixteen samples automatically, completes fifteen individual determinations in an hour, and prints the results. You can buy x-ray and optical emission spectrometers that are coupled to computers to translate light intensities directly into percentage concentration. What the future really holds is now in the imaginative minds of laboratory workers who have problems to solve.

The Effect of Radiation on the Uptake of Minerals in Tomatoes

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Biology Department, Alabama College

INTRODUCTION

It has been known for many years that radiation produces such effects as reduction of growth, fasciation, morphological abnormalities (Gunckel, 1957), changes in growth form and apical dominance (Sax and Schairer, 1963), growth potential (Cotter, 1963), and other gross morphological changes. Gunckel and Sparrow (1953) presented a complete review of some of the effects of radiation on plant growth. Likewise, genetic results have been extensively investigated revealing various effects of chromosomal aberrations and mutations. Lately attention has been turned to physiological and ecological effects, culminating in a symposium of radioecology in Fort Collins, Colorado, in 1961. Approximately 90 papers presented at the conference were published (Schultz and Klement, 1963).

Mineral nutrition, as one of the basic physiological aspects of plant growth, has far-reaching effects on the growth and survival of plants. As yet there have been few studies dealing with mineral uptake in irradiated plants. Generally they apply to the analyses of uptake by classical agricultural methods or in non-irradiated plants by the radioisotope method. Radioisotopes have been added to fertilizers for study of crop plant nutrition and many other types of tracer studies have been conducted (Bormann and Graham, 1959). The importance of radiation induced mineral deficiencies may reside in the possibility of secondary effects on plants because the deficiency of certain elements may alter the basic physiology of the plant.

If one is to fully understand the complex reactions of a plant following radiation exposure, it is necessary to recognize the possibility of nutrient deficiency as a contributing factor in later plant responses. The purpose of this research was to determine whether or not different levels of radiation affected the uptake of minerals as the plants grew.

MATERIALS AND METHODS

During the summer of 1963, young nursery stock tomato seedlings were exposed to 2000 r, 5000r, 10,000r, and 20,000 r of gamma radiation at the cesium field at Emory University in Atlanta, Georgia. These four treatments with an additional non-irradiated control group were brought to the campus of Alabama College for the remainder of the experiment. One set of the five treatments was planted outside the greenhouse in a shaded garden plot and the others were transplanted to a hydroponics bed in the greenhouse. A greenhouse bench was covered with a double layer of thin plastic sheets and filled with crushed styrofoam to support the tomato plants. As they grew they were given additional support when needed by strings. The plants were watered twice daily with nutrient solution (Miller, 1953) at 9:00 a.m. and 4:00 p.m., using approximately 18 to 20 liters of solution per day. Small pin holes in the bottom of the plastic allowed for drainage. The nutrient solution was made up in large quantities each day.

After allowing the plants three weeks to adapt to their new environment, samples were picked at random to be used for chemical analysis. The samples consisted of 5 plants—one from each radiation level and a control. One sample from the garden and three sets of samples from the hydroponics bed were selected to be assayed per week for five weeks. Thus 20 plants were analyzed per week for a total of 100 plants during the experiment.

The plants were sectioned into leaves, roots, and stems to be dried and weighed. The dry weight of each section of the plant and the total dry weight were determined. The dried organs were then crushed and mixed thoroughly before sampling. A sample from each organ was dissolved in 5 to 8 ml of nitric acid, filtered, and diluted to 100 ml with distilled water. The samples were analyzed by a Beckman Model DB flame spectrophotometer for the elements calcium, sodium, potassium, and magnesium. Each analysis was related to a standardized sample and the data were presented as a graph. The percentages of sodium and calcium in each organ of the plants were determined from the curves, but the data for magnesium and potassium were invalid due to technical difficulties pertaining to these elements.

The data collected from all the analyses were programmed for a computer and analyzed by the statistical department at the University of Georgia. Thirteen major variables were treated statistically including the weight of each of the organs, total weight, percentage of sodium and of calcium for each organ, as well as date (time), radiation, and location (hydroponics bed or garden). The use of the terms significant and very significant to describe the data referred to the 0.05 and 0.01 levels respectively.

RESULTS AND DISCUSSION

Early in the experiment it was obvious that the radiation dose did not approach the lethal dose for tomatoes and that higher levels of radiation would be necessary to produce major effects on plant growth and physiology. The radiation levels used were great enough to produce some effects and the results were indicative of the effects of sublethal radiation exposure.

A coefficient of correlation was determined for each of the aspects of weight, and percentages of sodium and calcium for the duration of growth and radiation treatments. A very significant degree of correlation (above 70%) was found within certain groups, such as the mean weight of each organ and the mean total weight. The mean percentages of sodium correlated very significantly between the different organs of the plants regardless of radiation treatment. In most cases the mean percentage of calcium correlated significantly between the different organs for the irradiated group but this correlation was not observed in the control group. This degree of correlation was not as high as those found for the growth and sodium content, but still ranged above 37%. These results indicate that growth of each of the plant organs and the percentages of sodium are interrelated, although they are different aspects of the total response of the plant. Calcium did not follow this simple relationship. The three factors were not intercorrelated at any radiation level or date and behaved as independent variables.

The weight of each plant organ increased proportionally as the date or growing time increased and decreased proportionally with increase in radiation dose (figure 1). The dose times date interaction or the action of dose as time increased on the weight of leaves was very significant. In the control group the response was linear up through the fourth week and then rose rapidly (figure 2). In the 2000 r group, the response leveled off in the fourth and fifth weeks. The 5000 r groups had leveling off in the second, third, and fourth weeks. The 10,000 r group response followed a cubic curve or a curve of a 3rd degree order. The 20,000 r group also had a linear response through the fourth week and then rose rapidly. The radiation dose affected the rate or growth of the plants as time increased.

A precise picture of the effect of radiation on growth was hard to obtain but in general followed the normal predictive pattern which is decreased plant growth following radiation treatments. A slight, but non-significant, increase in growth of plants exposed to 2000 r over the control group was revealed in the means of the two groups adjusted for date and date-dose interaction (figure 3). This might be indictative of the low level stimulative effects observed by McCormick and Platt (1962) and Sax (1963) and many others. A more obvious reaction might be noted at another dose level not tested (e.g., 2000 r might not be the level to promote maximum stimulation of growth in tomatoes).

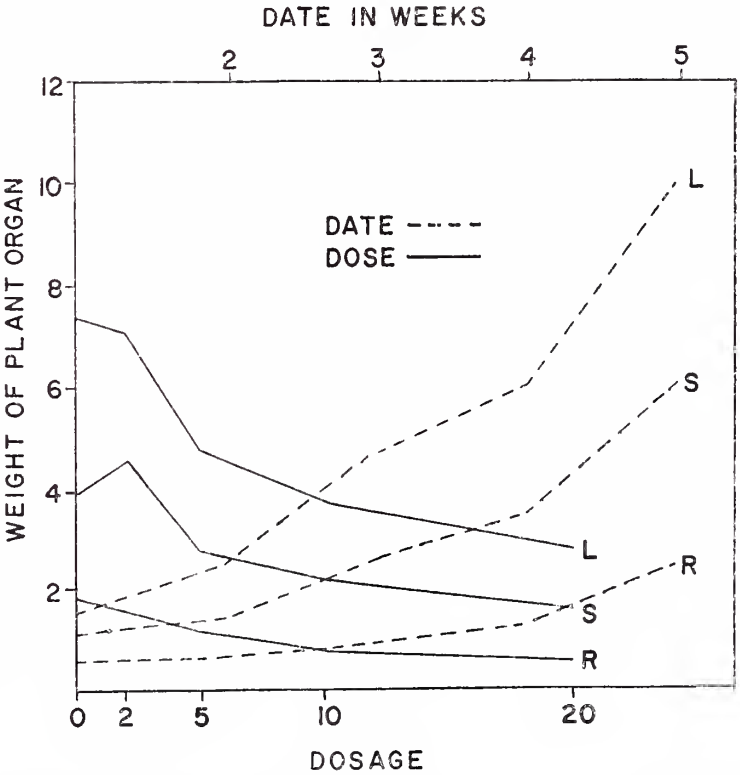

Figure 1. The effect of radiation and time on the growth of tomato organs. The letters L, S, and R refer respectively to leaves, stems, and roots. Dosage in kiloroentgens and weight in grams.

The relationship between the percentage of sodium in the plant organs and increase in time was very significant (figure 4). The percentage of sodium decreased rapidly through the third week, rose in the fourth week, and then in the fifth week, the percentage returned to the level of the third week. The rise in the level of sodium in the fourth week could not be accounted for. Sodium is not one of the essential elements needed for plant growth and was not supplied in the ingredients in the basic nutrient solution. The high levels of sodium within the plant, when compared with calcium,

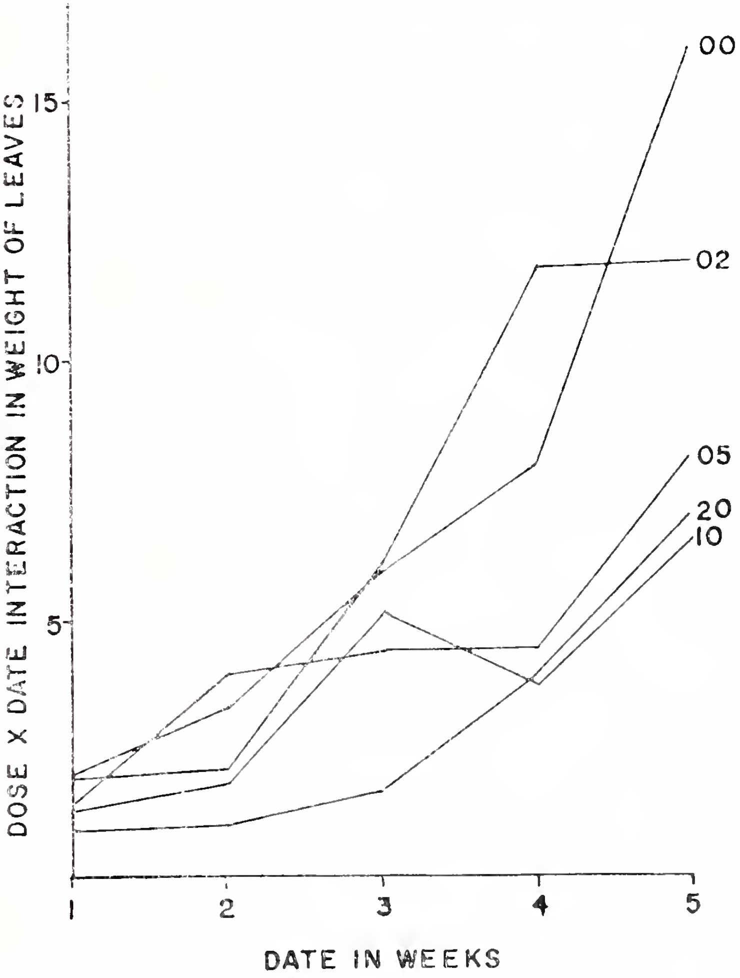

Figure 2. The relation of date to dose times date interaction on the weight of leaves. Figures 00, 02, 05, 10, and 20 refer to the level of radiation in kiloroentgens. Weight is given in grams.

are hard to interpret on this basis. It is possible that the sodium was accumulated in the plants prior to radiation or to transplant in simple uptake from the sandy soil of the crates which held the tomatoes when they were first purchased. The garden group followed the same pattern as the ones in the greenhouse. If the concentration of sodium was stable when the plants were introduced to

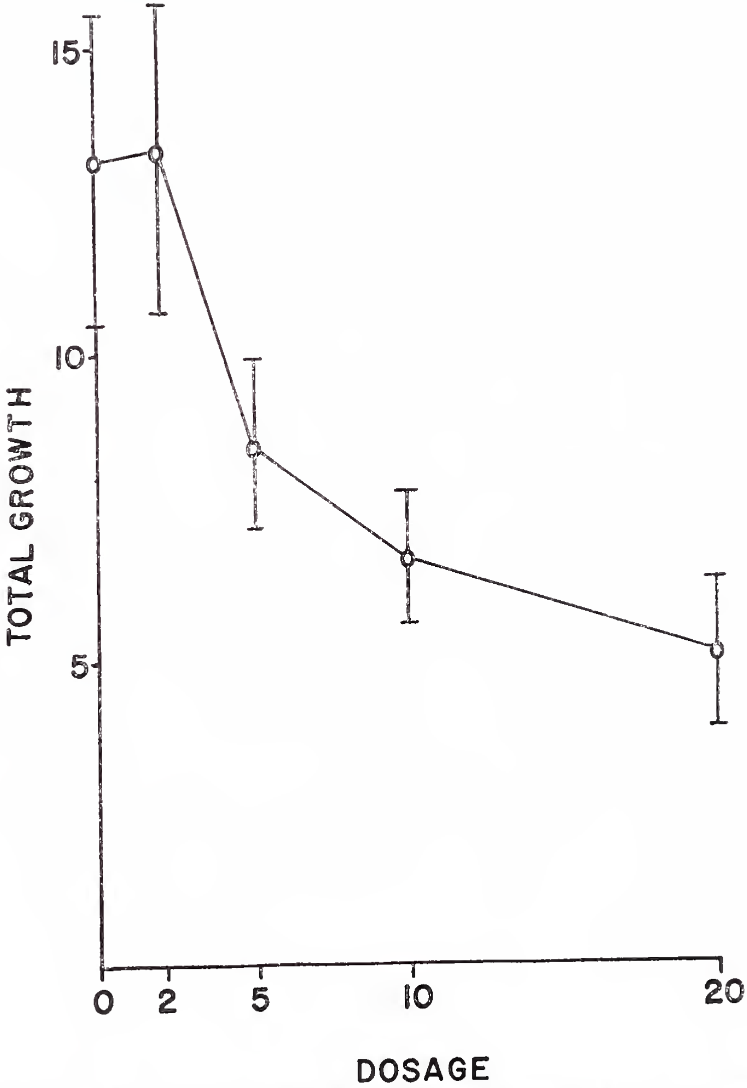

Figure 3. The effect of radiation on total plant growth with bars to designate one standard deviation of the means. Mean weight expressed in grams.

the nutrient solution devoid of sodium, the amount of sodium present in the plants would remain constant throughout the experiment. Thus it would be anticipated that the percentage of sodium found in each sample would decrease with date of sampling to compensate for the diluting effect of growth. The drop in the percentage of

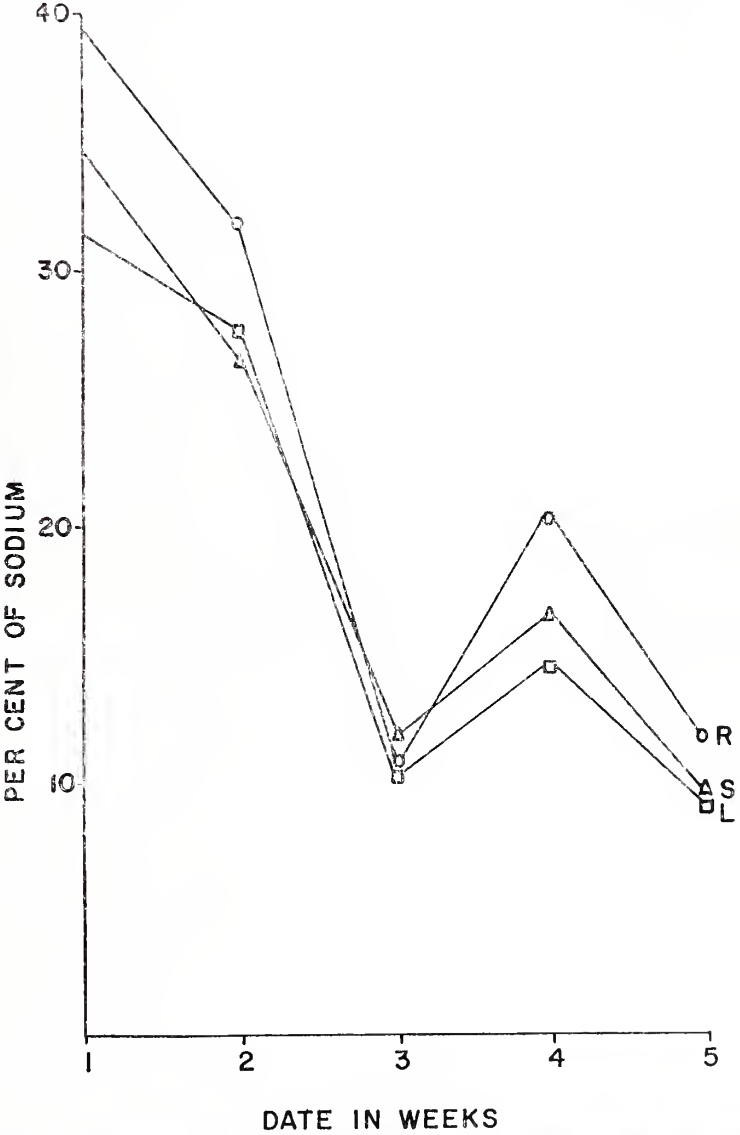

Figure 4. The effect of time on the percentage of sodium in plant organs. The letters L, R, and S refer respectively to leaves, roots, and stems.

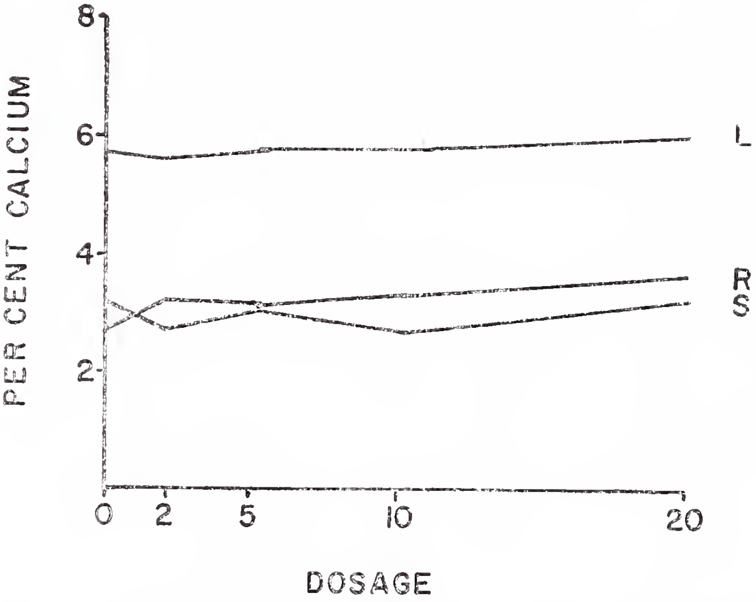

Figure 5. The effect of radiation on the percentage of calcium in plant organs. The letters L, S, and R refer respectively to leaves, stems, and roots. Dosage in kiloroentgens.

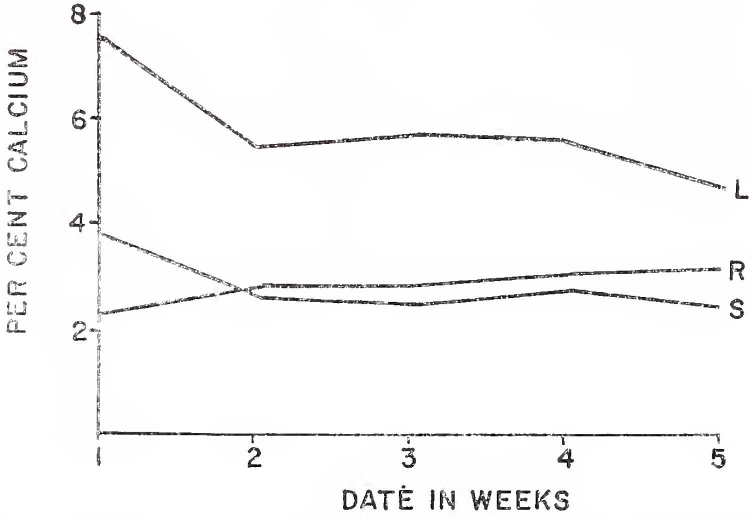

Figure 6. The effect of time on the percentage of calcium in plant organs. The letters L, S, and R refer respectively to leaves, stems, and roots.

sodium paralleled the increase in growth, as would be expected, except for the fourth week. The response of sodium is a little confused and needs clarification by further study.

The analysis showed a significantly higher percentage of calcium in the leaves than in either roots or stems, irrespective of the radiation treatment (figure 5). Therefore, radiation is not a factor in controlling the relative content of the different organs at the levels tested. There seemed to be a slightly higher percentage of calcium in each organ as the dose increased, but the difference was not enough to be significant. The percentages of calcium in leaves and stems were higher at the beginning of the experiment, but dropped and leveled off for the next three weeks and showed another decrease at the fifth week (figure 6). The percentage of calcium in the roots increased slightly with time. The reasons for these changes in content are unknown at the present time.

Table I. Summary of Significance in Analysis of Variance

	Wt. leaves	Wt. stem	Wt. root	Na. leaves	Na. stem	Na. roots	Ca leaves	Ca stem	Ca root
Dose		xx	x				xx		xx
Date	x		xx	xx	x	xx	xx	x	xx
D x D	xx								
Wt. of Plant								x	

x indicates significant at .05 level; xx, significant at .01 level.

Table I shows the results of the analysis of variance of the data. From this table it is possible to determine whether the effects of the different variables on the factors tested were significant. Thus the dose that the plants received significantly affected the weight of stem and root and the calcium content of the plant organs. Radiation did not significantly alter the sodium content of the organs nor the weight of the leaves. Similarly date, or the effects of time on growth showed significant or very significant effects on all aspects of the data with the single exception of the weight of stem. It can be observed that while the effect of dose on the weight of leaves was not significant, the effect of time was significant and the combined effects of time and dose were highly significant. Other relationships can be derived from the table such as the lack of significant influence of the weight of plant on mineral nutrition except for percentage of calcium in the stem. This table effectively summarizes the results of the experiment. Thus it has been shown that radiation and calcium metabolism of tomato plants are significantly related. The exact level to which they are related could not be determined.

The analyses of plants grown in the soil revealed essentially the same patterns of response for the factors tested as the plants grown in the hydroponics bed. This observation would need to be checked more thoroughly; the differences in mineral uptake could be checked in either rigidly controlled feeding regimes or under field conditions as long as the necessary minerals were available. A more exhaustive study considering different types of mineral solutions and different types of soil would be necessary to completely analyze the uptake of minerals in plants.

An apparent mineral deficiency which resembled closely the symptoms of iron deficiency appeared during the third week of sampling, but had disappeared by the end of the next week. A slight underturning of the leaf margins accompanied by a darkening of the leaf around the veins and a slight chlorosis of the interveinal area indicated some upset in the mineral nutrition of the plants in the hydroponics bed (Turner and Henry, 1939). This deficiency did not appear to be related to dosage, but was generally found throughout all the plants.

SUMMARY AND CONCLUSIONS

During the summer of 1963, several aspects of mineral nutrition and growth of irradiated tomato plants were investigated. Plants from four levels of radiation, 2000 r, 5000 r, 10,000 r, and 20,000 r, were grown in a nutrient solution or a garden. These were analyzed over a 5-week period for growth and the per cent composition of sodium and calcium by a flame spectrophotometer.

Radiation was found to cause a very significant decrease in the growth and to alter the calcium content of the plants. The effect of radiation as growth continued was highly significant in the weight of leaves. The percentage of calcium in each organ was increased slightly with dosage.

Whether the calcium uptake was sufficiently modified by the levels of radiation to seriously affect plant metabolism was not ascertained. However, evidences of radiation-induced changes in the mineral nutrition were not of sufficient magnitude to warrant its consideration as one of the facets of the radiation injury syndrome. Mineral nutrition may be of particular importance at higher dose levels approaching the lethal dose, but no trend was observed to support this hypothesis.

ACKNOWLEDGEMENTS

The author would like to gratefully acknowledge the assistance of the following persons who helped make this investigation possible: Mr. John McGinnis, Emory University, for irradiating the plants; Dr. James N. Carmon, University of Georgia, for statistical analyses; Dr. Samuel Cook, Alabama College, for assistance in some of the chemical aspects of analyzing the mineral content of the plants; and Dr. David Cotter, Alabama College, for directing the research. The financial assistance of an undergraduate research award from the National Science Foundation (Grant No NSG—G 22861) and a research grant from the Alabama Academy of Science are gratefully acknowledged.

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A Botanical Bonanza in the Black Belt

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The black belt of Alabama, because of its fertile soils, has had most of its area occupied by farmers for over 100 years. Because of this fact, very few areas large enough to harbor a variety of rare plants remain undisturbed. One small botanically unknown area near the Tombigbee River has been located recently by the author. It is too distant from all public transportation routes, such as railroads and bus lines, for the author to have discovered it in his early days of exploring Alabama by rail and on foot. It was discovered accidentally a few years ago while on an automobile trip with friends interested in botany.

It is in an area not at all typical of the more or less chalky black belt, since it is a strip (approximately two miles wide) of sandy and loamy soil bordering the river. This place is known as Smith Lake, and is on the east side of the river in Greene County, about two miles above Gainesville (Sumter County). The author was first directed to the area on October 29, 1960, by Mrs. John A. Rogers, Jr., of Gainesville, who has accompanied him on most subsequent visits, with members of the botany department at the University of Alabama furnishing most of the transportation.

The author recently found in his field notes records of a trip down the Warrior and Tombigbee Rivers with a party of geologists in October, 1908, which includes a description of a similar slough on the same side of the Tombigbee River in Marengo County south of the black belt. This area had many of the same plants as listed for the Greene County area, but apparently none of the rarer ones. The Greene County area is a slough about a quarter of a mile from the river and approximately parallel to it, probably an old river channel. It is reached by a dim road through fields, and where the road terminates there is a small area sufficient to park a car or two and launch a small boat on the slough.

The underbrush in the newly discovered area is fairly thick around the slough, perhaps because of the rarity of fire. The author had neither the time nor the energy to explore very far from the road terminus or boat landing, so that nearly all the plants listed for the area have been found within a few rods of that point. Presumably most, if not all of them, could be found at other places around the slough, but to walk around it would be a formidable task. Anyone who has a boat could easily circle it, but to go ashore anywhere but at the regular place, one would have to push through the bordering fringe of trees and wade the mud and water between low and high water mark, and then dodge through some thick underbrush.

The author has not attempted any measurements, but would estimate the slough to be about half a mile long and 100 yards wide, and 25 feet above the usual level of the river nearby. It would not be difficult to measure its depth with convenient equipment. Its normal seasonal fluctuation would appear to be about six feet. Its water is coffee-colored (like typical swamp water), but probably not very acid, for there is no peat. The presence of corn stalks, etc., lodged on bushes bordering the neighboring fields suggests that the entire area may be inundated by occasional floods of the river.

On one side, there is a large pile of sticks and brush a few feet high, presumably a beaver house. However, if any beavers live there they must be unemployed most of the time, since there would be no motive for building dams where there is no current. The water level must depend almost entirely on local precipitation and evaporation.

The slough is completely surrounded by a belt of trees with their roots in the water and enlarged conical bases reaching up to normal high water mark. They appear to be about three-fourths tupelo gum, *Nyssa uniflora,* and one-fourth cypress, *Taxodium distichum* (not *N. biflora* and *T. ascendens,* which would be in and around ponds with less fluctuation, farther down the coastal plain).

A very interesting feature of this tree belt is that most of the trees have around them, at or about high water mark, a collar of herbaceous vegetation, consisting mostly of *Triadenum petiolatum* and a species of *Bidens* with dissected leaves and inconspicuous flowers, and often *Boehmeria cylindrica* in addition. Similar collars, consisting primarily of *Lycopus,* can often be seen on dead trees or stumps in mill ponds or fish ponds made by damming up a creek without first cutting out the trees to be inundated.

Just how the plants of these collars became established is a puzzle, but the seeds must float on the water when it is high and lodge in cracks of the bark. The case of the *Bidens* is especially strange, for most species of that genus have barbed achenes, adapted to adhere to passing animals. A guess would be that they are transported by beavers, or whatever animals assembled the pile of brush. However, there is a *Bidens* in the north, *B. beckil* (now put in a separate genus, *Megalodonta*), whose stems float in still or slow-flowing water.

Another strange thing about the *Bidens* (which may be an undescribed species) is that its leaves are so delicate that they wilt quickly, making it difficult to prepare presentable herbarium specimens unless a press is readily available. And yet in nature they must often survive for many days without rain, and their roots have no soil in which water may be stored. The author has seen the same plants on nearby large shrubs or vines at about the same high water mark, but never growing in the ground.

A feature of the *Nyssa,* which may have been known for some time, but is seldom mentioned, is the fact that all the species produce drupes. These may pass through the alimentary canal of a bird and be deposited anywhere. The commoner species of *Nyssa* have small drupes which can be eaten by smaller birds.

N. uniflora (like *N. ogeche,* a very distinct species chiefly confined to Georgia) has drupes about an inch long and half an inch thick, which would be too large for most birds. In addition to their large size, these stones have several cartilaginous longitudinal wings which should be rather disconcerting to birds. These drupes fall in the water and may be carried downstream by floods, if not eaten by ducks. The seeds of the cypress also float when their cones break up.

The most remarkable plant in this area is yet to be mentioned. On the author's first visit, October 29, 1960, several days after the first frost, the plants to attract the most attention were growing on the muddy shores a few inches above high water mark. These plants consisted of a colony of long-petioled, evergreen, palmately dissected leaves, growing in tufts, as if each tuft came from a separate root. There was no immediate means of identifying them, but one of the members of the party collected some specimens and transferred them to the University of Alabama greenhouse with the intention of observing them until they bloomed. They remained in the greenhouse for months without blooming, and then the author suggested that they might need a resting period with low temperatures (winter), such as many herbs in temperate climates must have.

The author did not visit the area the following spring, however, on June 7, 1961, the area was visited again. The water was at an intermediate stage and the "mystery plants" appeared much the same as in the previous fall. This observation suggested spring as the flowering season. Some of the plants were below the surface of the water and others were above. None were collected.

The next visit was October 7, 1961, which was before the first frost. Herbarium specimens of the "mystery plant" were collected. At this time, the tufts of leaves were connected by what appeared to be slender prostrate stolons, something like those of *Fragaria* and *Potentilla*. However, its identity was still a puzzle.

Additional living plants were collected at that time and placed in a cold frame outside the University of Alabama greenhouse. A killing frost came in late November and immediately following this the plants were completely wilted, as if dead. In a few days, however, they were completely recovered, and at this time some photographs were made.

As spring advanced, the plants in the cold frame put out more leaves. The later ones were more finely dissected, and reminded the author of some aquatic species of *Ramunculus*, which have submerged, finely dissected leaves.

With this in mind, another visit to the area was arranged for March 24, 1962, a very appropriate date. A few yards from the temporary shore line, approximately where the clusters of leaves had been observed in the previous fall and where the water was now about a foot deep, were dozens of bright yellow flowers, evidently of *Ranunculus*, extending out of the water a few inches on elongated stems which were floating below the surface. All the flowers were solitary and terminal, but a closer examination of the specimens collected revealed several immature flowers farther back on the stem. These were doubtless to bloom later and take the lead one at a time when the older flowers mature and retreat below the surface to ripen their seeds. This was evidently a case of centrifugal or cymose inflorescence. The stems were rather stout, approximately a yard long, and provided with alternate, finely dissected leaves with a spread of about three inches.

References then led the author to a *Ranunculus* that has been given several different names, but is described in Fernald's Manual (1950) as *R. flabellaris* and its forma *riparius*. It was discussed at some length by Mr. Fernald in Rhodora, 38:171-173, with Plate 414, for May, 1936. The matter is rather complicated and it is not yet certain whether the northern plant which Mr. Fernald saw in the herbarium is the same as the one described above. However, the evidence now at hand seems to indicate that the "forma *riparius*" is not a true form, but a growth stage through which every plant must pass each year.

One might infer from the descriptions in the manuals that *R. flabellaris* can be found almost anywhere in the United States north of North Carolina and Arkansas, but there appears to be no previous report from Alabama or any adjoining state. It might well be that this plant, so widely separated from its relatives, is specifically distinct. Herbarium specimens do not tell the entire story in such cases, and a careful account of the life history of this plant would be a valuable contribution.

While this study was in progress, there appeared in the Bulletin of the Torrey Botanical Club for "January-February" 1962 (published in May) a detailed morphological study of the leaves of *Ranunculus flabellaris* by Jack M. Bostrack and W. F. Millington. The material for that study came from some unidentified locality in southern Wisconsin, and of course it could differ somewhat from the one described from Greene County. Their illustrations of summer leaves, however, appear to be the same. Very little was said about flowers in the Wisconsin material, but it was indicated that these plants bloom in late May. Bostrack and Millington studied their plants throughout the year in the greenhouse and found considerable variation in leaf form with the seasons and also between terrestrial and aquatic plants. They suggested various factors that might be responsible for the seasonal variations, among them the length of day.

Be that as it may, the seasonal variations in the Greene County area are correlated with the water depth, which must follow a fairly regular cycle from year to year, and would not necessarily correspond to that in the river, which might be affected by rainfall upstream. The average level of the water in the slough appears to be about 25 feet above the low water level in the river and, of course, it could not have such extreme fluctuations as the river.

Other interesting and possibly undescribed plants of this locality will be mentioned briefly, pending a study by taxonomists who have access to large herbaria for comparison. Some of them have not been collected, because only a few specimens were available.

During the first visit, a single flowering specimen and a few additional leaves of a *Lophotocarpus*, a genus not reported from Alabama, were observed. The best known species is *L. calycinus*, but that is said to have conspicuous sepals (whence its name) and those were not evident in the specimen observed, unless they had already fallen. A year later there was apparently the same plant in the same place, and it was photographed. However, in 1962 there were only leaves.

Nearby, there were several specimens of *Echinodorus radicans,* of the same family, which the author had never seen in Alabama before. Some specimens were collected in 1961.

In dry woods a few yards from the water, a few scattered specimens of an *Ambrosia* with simple leaves were observed in the fall of 1961. There were only a few plants in this area, but three specimens were collected and photographed together after drying. Additional specimens were later located on the river bank. After the plant is through blooming and the staminate racemes (usually only one to three) drop, it looks very much like *Diapedium brachiatum,* which also grows on the river bank.

It has been suggested that this is *Ambrosia trifida* var. (or forma) *integrifolia,* but *A. trifida* is a weed common in the streets of New York and various other places, and it would be very strange to make a native plant, such as this appears to be, a variety of a weed. But the ancestry of our weedy *Ambrosias* is a problem. Some of them are found occasionally in apparently natural habitats, and most botanists like to think that they have been there since prehistoric times. (See Bull. Torrey Bot. Club, July, 1908, and the author's bulletin on Alabama weeds, 1944.) Archaeologists have found seeds of what they take to be *A. trifida* in some prehistoric sites of human occupancy in the Mississippi Valley.

Also to be mentioned is a one-flowered *Clematis* (*Viorna*) with white flowers, about a yard high. Only two specimens were observed in April of 1962, and none were collected. A *Galium* with very small white flowers was found the same day and collected, but is not yet identified.

It would hardly be worthwhile to make a quantitative study of the vegetation in and around the slough at this time, since there are all gradations between permanent water and fairly dry woods, and it would be difficult to draw boundaries. The author now has records of about 75 species in the area, and the most common trees of timber size, arranging them in approximate order of abundance, are: *Nyssa uniflora, Taxodium distichum, Quercus Michauxii, Acer rubrum,* and *Pinus Taeda.* Small trees: *Morus rubra, Salix nigra.* Woody vines: *Berchemia scandens, Rhus radicans, Ampelopsis arborea.* Shrubs: *Cephalanthus, Sebastiana, Itea.* Herbs: *Ranunculus flabellaris* (?), *Triadenum petiolatum, Bidens* sp., *Boehmeria, Echinodorus.*

This account does not tell the whole story. Some interesting monographs could be written about either the flora or the vegetation, to say nothing of zoological problems with the beaver, the fish fauna, insects, and other forms of animal life.

In addition to the plants of natural habitats already mentioned, there is an unidentified *Cenothera* that blooms in late spring and early summer. It is common in a field near the slough, which does not seem to be cultivated every year.

A disconcerting prospect remains to be mentioned. For many years, a scheme has been agitated for backing up the Tombigbee River to make a navigable channel to connect it with the Tennessee, and one of the proposed dams would be somewhere near the area described. A dam for navigation purposes only could be built without flooding a great deal of land, since the banks of the river are high on both sides. However, a dam 50 feet high or more would make a backwater a mile wide or more and obliterate this wonderful place. There seem to be no topographic maps yet to show just what would happen.

There is no way of predicting when the planned developments might begin. Scientists may yet have a few years to study the area. Merely collecting all the plants in sight, as has been done recently in a few places about to be inundated by power dams, would fall far short of telling the whole story. There are enough ecological problems in the area described to keep ecologists busy for several years, especially since a round trip from any research center would be over 100 miles.

A Check List of the Mosses of Alabama

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Mohr (1901) published in his state flora the mosses known from Alabama at that time, together with notes on their distribution and habitat. The following list does not include all species listed by Mohr, but does include those specimens that have also been collected by the writer and are available at the present time either in the writer's possession or in the herbarium of the University of Alabama. For those specimens examined by the writer that are also listed in Mohr's work, an asterisk (*) is used to indicate the county in which Mohr reported the specimen.

For convenience, the families, genera, and species of mosses are alphabetically arranged.

AMBLYSTEGIACEAE

Amblystegium Juratzkanum Schimp. On wet Selma Chalk. Rare. Montgomery and Sumter Counties.

Amblystegium Kochii B. & S. On moist substrata. Rare. Chambers County.

Amblystegium serpens (Hedw.) B.S.G. On wet soil, base of trees and on rocks near streams. Common. Butler, Calhoun, Coffee, Lawrence, Mobile*, Monroe, Montgomery, St. Clair, Tuscaloosa, Walker, and Winston Counties.

Amblystegium varium (Hedw.) Lindb. On wet soil. Not uncommon. Baldwin, Lowndes, Mobile*, Monroe, Tuscaloosa, Washington, and Winston Counties.

Campylium chrysophyllum (Brid.) Lesq. and James. On fallen logs, stumps, base of trees and on soil. Common. Autauga, Bibb, Blount, Butler, Calhoun, Choctaw, Coffee, Colbert, Conecuh, Coosa, DeKalb, Fayette, Hale, Jackson, Jefferson, Lauderdale, Lawrence. Lee*, Limestone, Lowndes, Marion, Monroe, Montgomery, Randolph, St. Clair, Sumter, Talladega, Tuscaloosa, Walker, and Winston Counties.

Campylium hispidulum (Brid.) Mitt. On bark of trees near base and on damp, dead wood. Not common. Baldwin, Calhoun, Lawrence, Lee*, and Tuscaloosa Counties.

Cratoneuron filicinum (Hedw.) Roth. On calcareous soil in wet pasture, abundant over several acres. Rare, only one collection in Alabama (JCW No. 878) from Pickens County.

Hygroamblystegium orthocladon (P. B.) Grout. On wet soil, edge of streams. Not common. Butler, Marion, Montgomery, and Tuscaloosa Counties.

Hygroamblystegium tenax (Hedw.) O. E. Jenn. [*H. irriguum* (Wils.) Loeske.] Rare. On soil in spring, partially submerged. Calhoun, Crenshaw, and Winston Counties.

Leptodictyum riparium (Hedw.) Warnst. On rocks in water, or floating. Frequent south of the Fall Line, Barbour, Bibb, Calhoun, Dallas, Lee, Mobile, Tuscaloosa, and Wilcox Counties.

Sciaromium Lescurii (Sull.) Broth. Wet rocks in streams and wet sandstone in rockshelters. Not collected south of the Fall Line. Autauga, Cleburne, Cullman, DeKalb, Etowah, Jackson, Lamar, Lawrence, Marion, Morgan, Shelby, Walker and Winston Counties.

ARCHIDIACEAE

Archidium ohioense Schimp. The writer has not found representatives of this order in Alabama, but Lesquereux and James (1884) reported *Archidium ohioense* in meadows and waste fields in the Raccoon Mountains of Morgan County, collected by Lesquereux.

AULACOMNIACEAE

Aulacomnium heterostichum (Hedw.) B. S. G. (*Sphaerocephalus heterostichum* Bruch & Schimp.) On moist soil, banks of ravines and base of trees. Common in the northern section of the state but very infrequent in the south. Autauga, Bibb, Blount, Calhoun, Cherokee, Clay, Cleburne, Colbert, Crenshaw, Cullman*, DeKalb, Etowah, Fayette, Franklin, Hale, Jefferson, Lamar, Lauderdale, Lee*, Monroe, Montgomery*, Morgan, St. Clair, Talladega, Tuscaloosa, Walker, and Winston* Counties.

Aulacomnium palustre (Hedw.) Schwaegr. On soil and in swamps. Bibb, DeKalb, Etowah, Jackson, Mobile, Pickens, and Washington Counties.

BARTRAMIACEAE

Bartramia pomiformis Hedw. On moist soil, banks of ravines, and base of trees. Common in the northern half of the state. Blount, Calhoun, Clay, Colbert, Cullman, DeKalb, Etowah*, Fayette, Franklin, Hale, Jackson, Jefferson, Lamar, Lauderdale, Lawrence, Lee*, Marion, Tuscaloosa, Walker, and Winston* Counties.

Philonotis caespitosa Wils. On moist rocks and soil. Not common. Baldwin, DeKalb, Jackson, and Morgan Counties.

Philonotis capillaris Lindb. Only one collection (Harvill No. 5595), from a moist rock cliff in Jackson County.

Philonotis glaucescens (Hornsch.) Paris. Only one collection (Harvill No. 3066), found on shale in creek bed of a ravine near Lock 13 above Tuscaloosa in Tuscaloosa County.

Philonotis longiseta (Rich.) E. G. Britt. On wet soil and rocks near streams. Not uncommon. Autauga, Coffee, Cullman, Pickens, Tuscaloosa, Walker, and Winston Counties.

Philonotis uncinata (Schwaegr.) Brid. Only one collection from Alabama (JCW No. 879), taken from the bank of an over-flowing spring feeding a pond, 1 mile south of Aliceville in Pickens County.

BRACHYTHECIACEA

Brachythecium acutum (Mitt.) Sull. Rare, only one collection (Harvill No. 7137a), taken from sandstone rocks at Tucker's Gulf in Marion County.

Brachthecium flexicaule R. & C. On soil at base of trees. Not common. DeKalb and Lawrence Counties.

Brachythecium oxycladon (Brid.) J. & S. On soil around roots of trees. Not uncommon. Cullman, Hale, Lawrence, Sumter, Tuscaloosa, Walker, and Winston Counties. *Brachythecium oxycladon* var. *falcatum* Grout found in Lawrence County. *Brachythecium flagellare* (Hedw.) Jenn. is reported by Harvill from DeKalb, Marion and Walker Counties but not examined by the writer.

Brachythecium plumosum (Hedw.) B. S. G. On moist sandy soil. Not common. Dallas, DeKalb, Elmore, and Winston* Counties.

Brachythecium salebrosum (Hoffm.) B. S. G. On soil and limestone. Not uncommon. Bibb, Calhoun, Choctaw, DeKalb, Franklin, Lawrence, Marion, and Winston Counties.

Bryhnia graminicolor (Brid.) Grout. On soil and bark, base of trees. Infrequent. DeKalb, Hale, Lauderdale, and Lawrence Counties.

Chamberlainia acuminata (Hedw.) Grout. On moist soil and limestone boulders. Not uncommon. Bibb, Bullock, Choctaw, Colbert, Conecuh, Etowah, Hale, Lawrence, Limestone, Mobile, and Walker Counties.

Cirriphyllum Boscii (Schwaegr.) Grout. [*Eurhynchium Boscii* (Schwaegr.) J. & S.] On soil along the borders of woods and banks of ravines. Very common. Autauga, Blount, Butler, Calhoun, Cherokee, Cleburne, Coffee, Colbert, Conecuh, Coosa, Cullman, Dale, DeKalb, Elmore, Etowah, Geneva, Hale, Jackson, Jefferson, Lamar, Lauderdale, Lawrence, Lee*, Limestone, Marion, Marshall, Mobile*, Monroe, Randolph, St. Clair, Talladega, Tuscaloosa, Walker, and Winston Counties.

Eurhynchium hians (Hedw.) J. & S. [*Oxyrrhychium hians* (Hedw.) Loeske.] On moist soil in shaded places. Not uncommon. Autauga, Bibb, Coffee, DeKalb, Etowah, Hale, Jefferson, Lamar, Lee*, Marengo, Mobile, Sumter, Tuscaloosa, and Winston* Counties.

Eurhychium rusciforme (Neck.) Milde. [*Platyhypnidium rusciforme* (Neck.) Fleisch.] Rare, one collection (Harvill No. 5577), found with *Fissidens polypodioides* in a rockshelter at Long Island Falls in Jackson County.

Eurhynchium serrulatum (Hedw.) Kindb. [*Rhynchostegium serrulatum* (Hedw.) J. & S.] On sandy soil. Very common. Autauga, Bibb, Butler, Calhoun, Chambers, Coffee, Colbert, Conecuh, Coosa, Dale, Dallas, Elmore, Franklin, Geneva, Hale, Houston, Jackson, Lawrence, Lee*, Macon, Marion, Mobile*, Monroe, Montgomery, Perry, Pike, Russell, Tuscaloosa, Walker, and Winston Counties.

Eurhynchium strigosum (Hoffm.) Br. and Sch. [*E. pulchellum* (Hedw.) O. E. Jenn.] On wet soil. Infrequent. Cullman, Lowndes, and Tuscaloosa Counties.

Homalotheciella subcapillata (Hedw.) Card. On bark of deciduous trees. Rare. Conecuh and Jackson Counties.

Rhynchostegiella Curviseta (Brid.) Limpr. Growing on sandy soil at base of ironwood, edge of ravine. Extremely rare, identified by W. C. Steere. Found in Montgomery County, and representing an extension in range from Braxton County, West Virginia (Sharp, 1944).

BRYACEAE

Bryum argenteum Hedw. On sandy soil, especially in cracks of walks. A common weed. Blount, Calhoun, DeKalb, Etowah, Franklin, Lauderdale, Lowndes, Mobile*, St. Clair, and Tuscaloosa Counties.

Bryum bimum Turn. Only one collection (Harvill & Harper, 1947), on granite outcrop in Randolph County, present in abundance (determined by A. L. Andrews).

Bryum Caespiticium Hedw. On sandy soil, granite and damp walls. Not common. Calhoun, Mobile*, Randolph, and Tuscaloosa Counties.

Bryum capillare Hedw. Only one collection (JCW No. 749) from wet calcareous bank on Pea River in Coffee County (determined by A. J. Sharp.)

Bryum cernuum (Sw.) Lindb. On wet soil. Rare, only one collection, from Winston County.

Bryum pseudotriquetrum (Hedw.) Schwaegr. Infrequent. On moist soil in shaded places. Clark, Jackson, Lawrence, Mobile*, and Winston Counties.

Pohlia annotina (Hedw.) Loeske. Only one collection (Harvill No. 5086), from sandstone in rockshelter on Sipsey River in Winston County.

Pohlia cruda (L.) Lindb. Rare. On wet soil in Lawrence County.

Pohlia nutans (Schreb.) Lindb. On wet soil. Infrequent. Blount, Calhoun, Coffee, Marion, Mobile*, and Morgan Counties.

Pohlia Wahlenbergii (Web. & Mohr.) Andrews. Wet soil and sandstone rocks. Infrequent. Barbour, Colbert, Lawrence, Walker, and Winston Counties.

Rhodobryum roseum (Weis.) Limpr. On wet soil, rocks and banks in shaded places. Not common. Bibb, DeKalb, Lawrence, and Morgan Counties.

BRYOXIPHIACEAE

Bryoxiphium norvegicum (Brid.) Mitt. On wet vertical wall of rockshelter. Rare, and representing an extension in range of about 200 miles from Rugby, Tennessee (Steere, 1937). Winston County.

CALYMPERACEAE

Syrrhopodon texanus Sull. Found in a variety of habitats, especially on decaying wood and humus. Common throughout the state in lowlands. Baldwin, Cherokee, Cleburne, Coffee, Coosa, Cullman, Dale, Fayette, Franklin, Jackson, Lamar, Lawrence, Lowndes, Marion, Mobile*, Montgomery, Pike, Walker, Washington, and Winston Counties.

CLIMACIACEAE

Climacium americanum Brid. On wet soil and rocks. Common north of the Fall Line. Calhoun, Cherokee, DeKalb, Lawrence, Lee*, Marion, Shelby, Tuscaloosa, Walker, and Winston Counties.

Climacium Kindbergii (R. & C.) Grout. On wet soil and rocks. More common north of the Fall Line. Blount Calhoun, Clarke, Clay, Cullman, DeKalb, Elmore, Jackson, Lawrence, Morgan, Tuscaloosa, and Washington Counties.

CRYPHACEAE

Cryphaea glomerata Schimp. On bark of deciduous trees. Not uncommon in the Coastal Plain, but not found by the writer north of the Fall Line. Butler, Coffee, Conecuh, Houston, Macon, Mobile*, Montgomery*, and Pike Counties.

DICRANACEAE

Campylopus atrovirens DeNot. Soil of cliffs. Rare. DeKalb and Marion Counties.

Campylopus flexuosus (L.) Brid. On moist soil and rocks. Common north of the Fall Line, rare to the south. Coffee, DeKalb, Franklin, Jackson, Lawrence, Marion, Morgan, Tuscaloosa, and Winston Counties.

Campylopus gracilicaulis Mitt. Sandy woods and fields. More common near the coast. Covington, Escambia, and Lawrence Counties.

Campylopus introflexus (Hedw.) Brid. On limestone boulders. Frequent in the northern part of state. DeKalb, Franklin, Marion, and Winston Counties.

Campylopus tallulensis Sull. & Lesq. On siliceous ledges and soil. Not common. Autauga, DeKalb, and Lawrence Counties.

Dicranella Herminieri Besch. On moist soil, edge of bog. Rare. Jackson County.

Dicranella heteromalla (Hedw.) Schimp. On moist sandy soil. Not common. Marion and Tuscaloosa Counties.

Dicranella rufescens (Sm.) Schimp. On moist sandy soil. Rare. Tuscaloosa County.

Dicranella varia (Hedw.) Schimp. On moist soil overlying rocks and on banks. Infrequent. Lawrence and Marion Counties.

Dicranodontium denudatum (Brid.) E. G. Britt. On soil and siliceous boulders, rarely on rotten wood. Common, more so north of the Fall Line. Cherokee, Cleburne, Coffee, Cullman, DeKalb, Elmore, Franklin, Jackson, Jefferson, Lamar, Lawrence, Marion, Morgan, Walker, and Winston Counties.

Dicranum condenstatum Hedw. On sandy soils and rocks. Most common along the Gulf Coast. Baldwin, Marion, Pike, and Winston Counties.

Dicranum flagellare Hedw. On decaying logs. Not common. Cherokee, Etowah, and Pike Counties.

Dicranum fulvum Hook. On soil overlying sandstone boulders. Common north of the Fall Line. DeKalb, Franklin, Tuscaloosa, and Winston Counties.

Dicranum scoparium Hedw. On soil of wooded hillsides. Common. Calhoun, Cherokee, Clay, Cleburne, DeKalb, Etowah, Franklin, Houston, Jackson, Jefferson, Lauderdale, Lawrence, Marion, Morgan, Randolph, Tuscaloosa, and Winston* Counties.

DIPHYSCIACEAE

Diphyscium cumberlandianum Harvill, sp. nov. On dry soil and on conglomerate boulders. Collections from four counties in the Cumberland Plateau have been made (Cullman, Franklin, Lawrence and Winston Counties), from two counties in the northwest portion of the Upper Coastal Plain (Lamar and Marion Counties), and one collection from the Lower Coastal Plain (Choctaw County-Harvill, 1952). This new species of moss was described by Harvill (1950) as follows:

"*Diphyscium cumberlandianum* Harvill, sp. nov. Plantae 11-12 mm. alti, dense caespitosa, fusca. Folia caulina conferta, ad 5.5 mm. longa, sicca crispata, humida erecto-patentia, lingulata-lanceolata, integerrima, apice acuta, costa percurrente, cellulae superiores minutae, obscurea, laevis, e duplici strato, cellarum efformata, basilares, rectangulares, incrassatis. Flores dioici; folia perichae-tialia costa excurrente, longissime aristata, basi et costa rufescentibus. Seta brevis; capsula ovato-cylindrica, 8 m.m. longa immersa. Ad rupes muscosas humidiuscules."

The type is in the Herbarium of the University of Alabama; cotypes are in the herbaria of Edwin B. Bartram and the University of Michigan. This new species was found growing on top of a conglomerate boulder at the base of King Cove, Lawrence County, July 28, 1949, Harvill No. 5464.

Diphyscium foliosum (Hedw.) Mohr. On sandy and rocky soil. Not uncommon in the northern part of the state, but not found by the writer south of the central portion. Etowah, Jefferson, Lamar, Lawrence, Walker, and Winston Counties.

DITRICHACEAE

Ditrichum lineare (Sw.) Lindb. [*D. vaginans* (Sull.) Hampe]. On sandy, bare soil. Rare. Winston County.

Ditrichum pallidum (Hedw.) Hamp. On dry sandy soil of fields and banks. One of the most common mosses. Autauga, Baldwin, Blount, Bullock, Calhoun, Chambers, Coffee, Conecuh, Coosa, Covington, Dale, DeKalb, Franklin, Houston, Jackson, Jefferson, Lauderdale, Lowndes, Marion, Montgomery, Russell, St. Clair, Tuscaloosa, Washington, and Winston Counties.

Pleuridium subulatum (Hedw.) Lindb. On sandy soil. Rare. Lee* and Tuscaloosa Counties.

ENTODONTACEAE

Entodon cladorrhizans (Hedw.) C. Muell. On rich wet humus and rotten bark. Very infrequent. Coffee, Etowah, Pike, and Mobile Counties.

Entoden Drummondii (B. S. G.) J. & S. On rotten stumps, base of trees, logs and rocks. Not uncommon. Choctaw, Cleburne, Conecuh, Dale, DeKalb, Etowah, Hale, Lawrence, Mobile*, Monroe and Tuscaloosa Counties.

Entodon seductrix (Hedw.) C. Muell. Found in a variety of habitats. Common. Baldwin, Bibb, Butler, Calhoun, Cleburne, Coffee, Conecuh, Coosa, Dale, DeKalb, Elmore, Houston, Jefferson, Lauderdale, Lawrence, Lowndes, Marion, Montgomery, Morgan, Perry, Pike, Tuscaloosa, and Washington Counties.

FABRONIACEAE

Clasmatodon parvulus (Hampe) Sull. On bark of deciduous trees. Frequent. Bibb, Cherokee, Coffee, Conecuh, Covington, Etowah, Lawrence, Lee*, Limestone, Lowndes, Marion, Mobile*, Montgomery, Pickens, Talladega, and Winston Counties.

Fabronia Ravenelii Sull. (*F. caroliniana* S. & L.) On rocks and trees, and not common. Cullman, Fayette, Lamar, Lee*, and Winston Counties.

Schwetschkeopsis denticulata (Sull.) Broth. On bark and sandstone boulders. Very infrequent. Conecuh, Lawrence, and Marion Counties.

FISSIDENTACEAE

Fissidens adiantoides (Hedw.) Wet shaded soils, common at base of trees. Not infrequent. Dale, DeKalb, Etowah*, Franklin, Lee*, Morgan, and Winston Counties.

Fissidens bryoides (Hedw.) On soil in Tucker's Gulf, Marion County (Harvill No. 7146). Very rare.

Fissidens cristatus Wils. Wet soils and rocks. Not uncommon. Cherokee, Choctaw, Cleburne, Coffee, Dale, DeKalb, Lawrence, Marion, Morgan, Pike, and Tuscaloosa Counties.

Fissidens Donnellii Aust. On soil at base of tree in Stuck's Bluff in Marion County and in Mobile* County.

Fissidens Julianus (Mont.) Schimp. [*Octodiceras julianum* (Savi) Brid.] Floating in clear streams from springs. Found in abundance in Calhoun County and Talladega* County.

Fissidens minutulus Sull. Found on wet rocks in Marion County, on red clay under doorsteps in Calhoun County, and in Mobile* County.

Fissidens obstusifolium Wils. On soil, at times submerged. Not common. DeKalb, Talladega and Winston Counties.

Fissidens osmundioides Hedw. On moist shaded soil. Common. Butler, Clay, Coosa, Cullman, Dale, DeKalb, Etowah, Jackson, Jefferson, Montgomery and St. Clair Counties.

Fissidens polypodioides (Hedw.) On wet soil and humus in shaded woods. Not found south of the Fall Line but common to the north. DeKalb, Etowah*, Franklin, Jackson, Lamar, Lawrence, Marion, Walker, Winston, and Tuscaloosa Counties.

Fissidens subbasilaris Hedw. On rocks and bark of trees at base. Our most common species. Bibb, Butler, Calhoun, Coosa, Cullman, Dale, Etowah, Hale, Jackson, Lawrence, Lee*, Marion, Mobile*, Pike, Randolph, Tuscaloosa, Washington, and Winston Counties.

Fissidens taxifolius Hedw. On damp rich soil and clay. Common. Choctaw, Clarke, Cleburne, Conecuh, DeKalb, Hale, Jackson, Jefferson, Marion, Mobile*, Monroe, and Winston Counties.

FONTINALACEAE

Funaria flavicans Mx. On moist, sandy soil. Very infrequent. Calhoun, Lee*, Mobile*, and Sumter Counties.

Funaria hygrometrica Hedw. On moist calcareous soils and ashes. Common. Bibb, Calhoun, Clarke, Houston, Jackson, Lawrence, Macon, and Pike Counties.

Funaria serrata Brid. On moist soil and sandstone rocks. Not uncommon. Blount, Jackson, Lee*, Marion, Mobile, Morgan, and Walker Counties.

Physcomitrium turbinatum (Mx.) Brid. On moist, sandy soil, borders of fields and roads. Not uncommon. Baldwin, Butler, Calhoun, Coosa, Lee*, Macon, Mobile*, Sumter, and Tuscaloosa Counties.

GRIMMIACEAE

Grimmia apocarpa (L) Hedw. On limestone boulders. Common north of the Fall Line. Bibb, Colbert, Franklin, Madison, and Marshall Counties.

Grimmia apocarpa var. conferta (Funck.) Spreng. On limestone boulders. Found in the Cheaha Mountain region. Calhoun and Cleburne Counties.

Grimmia laevigata (Brid.) Brid. [*G. campestris* (Hook.) Bursch; *G. leucophaea* Grev.] On limestone boulders. Very common. Cherokee, Cleburne, Cullman*, DeKalb*, Jackson, Marion, Morgan, and Winston* Counties.

Grimmia pilifera Beauv. On siliceous boulders. Common, reaching its southern limit in Alabama along the Fall Line in Elmore County. Found also in Clay, Cullman*, Etowah, Marion, Randolph, St. Clair, Talladega, Tuscaloosa, and Winston Counties.

Rhacomitrium aciculare Brid. [*Grimmia aciculare* (L) K. Muell.] Not common. Cullman*, DeKalb, and Jackson Counties.

Rhacomitrium heterostichum (Hedw.) Brid. On sandstone boulders in northern Alabama. Not common. Cullman, Marion, and Winston Counties; the variety *R. heterostichum sudeticum* (Funck.) Jones is found on boulders in Etowah County.

HEDWIGIACEAE

Hedwigia ciliata (Ehrh.) Hedw. [*H. albicans* (Web.) Lindb.] On dry boulders. Common north of the Fall Line, but rare south of the Fall Line. Blount, Calhoun, Clay*, Cleburne, Colbert, Coosa, Cullman*, DeKalb*, Elmore, Etowah, Hale, Jackson, Lawrence, Lee*, Marion, Morgan, Randolph, St. Clair, Tuscaloosa, and Winston Counties.

HOOKERIACEAE

Hookeria acutifolia Hook. (*H. Sullivantii* C. Muell.) On soil and rocks near streams. Not uncommon north of the Fall Line, but rare south of it. Blount, DeKalb, Franklin, Jackson, Lamar, Lawrence, Marion, Talladega, Walker, and Winston Counties.

HYPNACEAE

Amblystegiella subtilis (Hedw.) Loeske. Very rare, only one collection (JCW No. 212), on bark of *Quercus virginiana* Mill. at edge of bog, Gulf Shores in Baldwin County.

Brotherella tenuirostris (Schimp.) Broth. (*Hypnum cylindrocarpum* C. Muell.) Only one collection (Harvill No. 6919), found on sandstone at Cave Springs in Lawrence County.

Homomallium adnatum (Hedw.) Broth. Bark, base of trees and occasionally on rocks. Common. Calhoun, Coffee, Houston, Jefferson, Lamar, Lee, Limestone, Pickens, Pike, and St. Clair Counties.

Hypnum curvifolium Hedw. On wet sandy soil, humus, dead trees and boulders. Common. Cleburne, Cullman, DeKalb, Etowah*, Franklin, Jackson, Jefferson, Lawrence, Lee*, Marion, Pike, Randolph, Tuscaloosa, Walker, Washington, and Winston Counties.

Hypnum imponens Hedw. On rotten logs and base of trees in wet places. Infrequent. Lawrence and Walker Counties.

Hypnum molluscum Hedw. [*Ctenidium molluscum* (Hedw.) Mitt.] On wet humus and soil. Not uncommon. Cleburne, Dale, DeKalb, Etowah, Hale, Jackson, Lauderdale, Talladega, and Winston Counties.

Hypnum patientiae Lindb. (*H. arcuatum* Lindb.) On wet logs and soil. Common. Autauga, Butler, Coffee, Dale, DeKalb, Elmore, Etowah, Fayette, Franklin, Greene, Houston, Jackson, Lawrence, Randolph, Talladega, Tuscaloosa, and Winston Counties.

Hypnum pratense Koch. On wet humus and soil. Infrequent. Bibb, Clay, Jackson, Lee*, Mobile, and Tuscaloosa Counties.

Mittenothamnium diminutivum (Hampe) E. G. Britt. On bark of trees near base, rotten stumps and logs. Rare. Lawrence and Winston Counties.

Platygyrium repens (Brid.) B. S. G. On bark of trees and dead logs. Not common. Jackson, Lawrence, Tuscaloosa, and Winston Counties.

Pylaisia polyantha Bry. Eur. On bark of trees. Not common. Butler, Coffee, Dale, and DeKalb Counties.

Pylaisia Schimperi Cardot. On bark of trees. Rare, only one collection (JCW No. 605), on bark of black gum in Randolph County.

Sematophyllum adnatum (L) E. B. Britt. On bark of trees and on dead logs and stumps. Common. Baldwin, Conecuh, Covington, Franklin, Jackson, Jefferson, Lawrence, Marion, Monroe, Montgomery, Morgan, Pike, Russell, Tuscaloosa, Walker, Washington, and Winston Counties.

Sematophyllum carolinianum (C. Muell.) E. G. Britt. On wet rocks. Rare. Calhoun, Cleburne, and DeKalb Counties.

Sematophyllum marylandicum (C. Muell.) E. G. Britt. On wet rocks. Rare. Cherokee, DeKalb, and Jackson Counties.

LESKEACEAE

Anomodon attenuatus (Schreb., Hedw.) Hueben. On trees, roots and soil near streams. Very common. Autauga, Bibb, Blount, Butler, Calhoun, Clay, Cleburne, Coffee, Conecuh, Coosa, Cullman, Dale, DeKalb, Etowah, Fayette, Franklin, Hale, Houston, Jackson, Jefferson, Lauderdale, Lawrence, Lee*, Limestone, Marion, Marshall, Montgomery, Morgan, Pickens, Pike, Randolph, St. Clair, Tuscaloosa, Walker, Washington, and Winston* Counties.

Anomodon minor (P. B.) Lindb. On bark and soil at base of trees. Not common. Coffee, Lauderdale, Lawrence, and Limestone Counties.

Anomodon rostratus (Hedw.) Schimp. At base of trees and stumps. Lauderdale, Limestone, Madison, Colbert, Lawrence, Marshall, DeKalb, Marion, Winston, Cullman, Etowah, Cherokee, Lamar, Fayette, Walker, Calhoun, Cherokee, Cleburne, Pickens, Tuscaloosa, Talladega, Clay, Randolph, Bibb, Hale, Lee, Autauga, Montgomery, Monroe, Butler, Perry, and Conecuh Counties.

Haplohymenium triste (Cesati) Kindb. On bark of trees at base. Not uncommon north of the Fall Line, but according to Schornherst (1943) found before only in Georgia and Florida extending into the coastal plain region. Cullman, Jefferson, Madison, Marion, Pickens, Pike, Randolph, and Walker Counties.

Leskea australis Sharp. Very infrequent, but probably overlooked. Only three collections: JCW No. 508 on bark of cedar in Limestone County (determined by W. C. Steere); Harvill No. 3784b on rotten stump in Choctaw County; and Harvill No. 6965 on *Quercus nigra* in swamp in Washington County.

Leskea denticulata Sull. Very rare, only one collection examined: JCW No. 722, on bark of magnolia about 50 feet from river in Dale County; Mohr (1901) lists collections from Lee County (Baker & Earle) and Montgomery County.

Thuidium delicatulum (Hedw.) Mitt. On soil, stumps and rotten logs in wet places. Common. Autauga, Butler, Calhoun, Cherokee, Choctaw, Clay, Cleburne, Coffee, Colbert, Conecuh, Coosa, Crenshaw, DeKalb, Etowah, Franklin, Hale, Houston, Jackson, Jefferson, Lamar, Lawrence, Macon, Marion, Montgomery, Pike, Randolph, Sumter, Talladega, Tuscaloosa, Walker, Washington, and Winston Counties.

Thuidium microphyllum (Hedw.) Best. On limestone boulders and base of *Taxodium*. Infrequent. Baldwin, Dale, Dallas, Lee*, Mobile*, and Morgan Counties.

Thuidium minutulum (Hedw.) B. S. G. Only two collections in Alabama, both in Washington County: Harvill No. 5787, on rotten log near St. Stephens, and Harvill No. 5791, on base of *Nyssa* near Chathem.

Thuidium pygmaeum B. S. G. One collection in the state: Harvill No. 6879, on soil at Welcome Falls in Cullman County.

Thuidium recognitum (Hedw.) Lindb. On moist soil, stumps and rotten logs. Common. Autauga, Blount, Butler, Calhoun, Cleburne, Coffee, Dale, DeKalb, Franklin, Jackson, Lauderdale, Lawrence, Lee (collected by Baker and Earle), Lowndes, Macon, Monroe, Montgomery, St. Clair, Talladega, and Winston Counties.

Thuidium scitum (P. B.) Aust. Only one collection (Harvill No. 7153), on sandstone at Bear Creek Falls, in Marion County, with *Climacium americanum* Brid.

Thuidium virginianum (Brid.) Lindb. Rare, with two collections examined; Harvill No. 6822 and No. 6823, both from stump in swamp near McIntosh, Washington County.

LEUCOBRYACEAE

Leucobryum albidum (Brid.) Lindb. On decaying stumps and logs and on roots. Very common throughout the state. Butler, Calhoun, Choctaw, Cleburne, Coffee, DeKalb, Escambia, Fayette, Franklin, Hale, Jackson, Jefferson, Lawrence, Marion, Mobile*, Monroe, Pike, Randolph, Sumter, Tuscaloosa, and Winston Counties.

Leucobryum glaucum (Hedw) Schimp. On soil of hillsides. One of our most common mosses. Baldwin, Bibb, Butler, Calhoun, Cherokee, Choctaw, Clay, Cleburne, Coffee, Colbert, Conecuh, Coosa, Crenshaw, Cullman, Dale, DeKalb, Escambia, Franklin, Geneva, Hale, Houston, Jackson, Jefferson, Lamar, Lawrence, Marion, Mobile*, Montgomery, Morgan, Pike, Randolph, St. Clair, Talladega, Tuscaloosa, Walker, Washington, and Winston Counties.

LEUCODONTACEAE

Leptodon trichomitrion (Hedw.) Mohr. On bark of trees, especially on cedar, and not uncommon. Coffee, Conecuh, Coosa, Dale, Etowah*, Lauderdale, Lee, Limestone, Mobile*, Randolph, Sumter, and Tuscaloosa Counties.

Leucodon brachypus Brid. On bark of trees, and very common. Blount, Butler, Chambers, Cherokee, Clay, Cleburne, Coffee, Colbert, Cullman, Greene, Lauderdale, Limestone, Marengo, Mobile, Montgomery, Pickens, Pike, Randolph, Russell, St. Clair, Tuscaloosa, and Winston* Counties.

Leucodon julaceus (Hedw.) Sull. On bark of trees. Very common throughout the state. Baldwin, Bibb, Blount, Butler, Calhoun, Chambers, Cherokee, Choctaw, Clay, Cleburne, Coffee, Conecuh, Coosa, Covington, Cullman, Dale, DeKalb, Elmore, Escambia, Etowah, Jackson, Jefferson, Lauderdale, Lawrence, Lee, Limestone, Lowndes, Macon, Marengo, Marion, and Marshall Counties.

MNIACEAE

Mnium affine Bland. On wet soil and humus. Common, more so north of the Fall Line. Autauga, Blount, Calhoun, Cleburne, Colbert, Dallas, DeKalb, Etowah, Franklin, Hale, Houston, Lamar, Lawrence, Lee*, Marion, Morgan, Montgomery, Pickens, Tuscaloosa, Walker, and Winston Counties.

Mnium cuspidatum Hedw. On moist soil and humus. Common. Autauga, Bibb, Blount, Calhoun, Cleburne, Coffee, Conecuh, Coosa, Crenshaw, Dallas, Fayette, Greene, Hale, Lauderdale, Lawrence, Lee*, Morgan, Montgomery, Pickens, Pike, Sumter, Walker, and Winston Counties.

Mnium hornum Hedw. On moist soil of stream banks and in shaded woods. Infrequent and not found below the Fall Line. DeKalb, Franklin, Lamar, Marion, Talladega, Walker, and Winston Counties.

Mnium longirostre Brid. (*M. rostratum* Schrad.) On moist soil. Not uncommon. Blount, Calhoun, Choctaw, Cleburne, Coffee, Conecuh, DeKalb, Etowah, Hale, Houston, Lauderdale, Lawrence, Marion, Pickens, Pike, Walker, and Winston Counties.

Mnium punctatum (Reich.) Hedw. On wet soil. Rare, found only in northern part of the state. Franklin, Jackson, Lamar, Lawrence, and Winston Counties.

Mnium stellare (Reich.) Hedw. On moist sandstone cliff. Only one collection (Harvill No. 5715), from King Cove in Lawrence County.

NECKERACEAE

Neckera complanata (Hedw.) Hueben. On wet shaded soil. Not common. Coffee, DeKalb, Marion, and Montgomery Counties.

ORTHOTRICHACEAE

Drummondia prorepens (Hedw.) O. E. Jenn. (*D. clavellata* Hook.) On bark of deciduous trees, especially fallen oaks, and hickories. Common, but not found south of the Fall Line. Calhoun, Clay, Cleburne, Coosa, Jefferson, Lauderdale, Lee*, Talladega, and Winston* Counties.

Orthotrichum pumilum Dicks. On bark of trees. Infrequent. Lee*, Macon, Pike, Russell, and Winston Counties.

Orthotrichum pusillum Mitt. (*O. psilocarpum James*). On bark of trees. Infrequent. Calhoun, Lauderdale, Limestone, Morgan, and Pike Counties.

Orthotrichum strangulatum Schwaegr. (*O. Porteri* Aust.) On limestone boulder in open woods of hillside. Rare, only one collection from Colbert County.

Schlotheimia Sullivantii C. Muell. On bark of trees. Common in the lower Coastal Plain but not found by the writer north of the Fall Line. Baldwin*, Conecuh, Covington, Mobile*, and Montgomery[3] Counties.

Ulota americana (P. B.) Limpr. On rocks. Not common. DeKalb, and Jackson Counties.

PLAGIOTHECIACEAE

Plagiothecium denticulatum (Hedw.) B.S.G. On moist humus. Only one collection examined by the writer (JCW No. 84) which was collected from humus at the base of oak in the Pocosins in Pike County. Mohr (1901) reports this species from Lee and Winston Counties.

Plagiothecium deplanatum (Sull.) Grout. Only one collection of this species (JCW No. 711), from soil of sandy bank in Dale County.

Plagiothecium elegans (Hook.) Sull. [*Isopterygium elegans* (Hook.) Lindb.] On moist rocks and soil. Not common. Baldwin, Bibb, Dale and Winston Counties.

Plagiothecium geophilum (Aust.) Grout. On rocks in streams. Only one collection (Harvill No. 4006), from Cleburne County.

Plagiothecium micans (SW.) Paris. [*Isopterygium micans* (Sw.) E. G. Britt.] On moist soil and humus, logs and base of trees. Common. Baldwin, Bibb, Blount, Bullock, Calhoun, Coffee, Conecuh, Dallas, Etowah, Franklin, Hale, Jackson, Lamar, Lawrence, Macon, Marion, Marshall, Mobile*, Monroe, Montgomery, Pike, Randolph, Russell, Sumter, Tuscaloosa, Washington, and Winston Counties.

Plagiothecium Muellerianum Schimp. On moist rocks on the Cumberland Plateau. Infrequent. Franklin, Lawrence, Walker, and Winston Counties.

Plagiothecium turfaceum (Lindb). Lindb. On moist soil and decayed humus in shaded places. Common north of the Fall Line. Calhoun, Cherokee, Lauderdale, Lawrence, Limestone, Walker, and Winston Counties.

POLYTRICHACEAE

Atrichum angustatum (Brid.) B.S.G. On moist sandy soil. One of our most common species of moss. Blount, Calhoun, Cherokee, Cleburne, Coffee, Colbert, Conecuh, Coosa, Cullman, Dale, DeKalb, Elmore, Escambia, Etowah, Franklin, Geneva, Greene, Hale, Houston, Jackson, Lauderdale, Lawrence, Lee*, Limestone, Marion, Mobile*, Pickens, Pike, Randolph, St. Clair, Talladega, Tuscaloosa, Walker, Washington, and Winston Counties.

Atrichum Macmillani (Holz.)Frye. On dry, sandy, unfertile soil. Not common. Franklin, Lamar, and Lawrence Counties.

Atrichum undulatum (Hedw.) Beauv. On moist sandy soil. Common throughout the state. Autauga, Calhoun, Colbert, Dale, DeKalb, Etowah, Franklin, Jackson, Jefferson, Lamar, Lawrence, Macon, Marion, Morgan, Montgomery, Pike, Walker, and Winston Counties.

Pogonatum brachyphyllum (Rich.) Beauv. On sandy soil and clay banks. Very infrequent. Cullman, Lawrence, and Pike counties.

Pogonatum pensilvanicum (Hedw.) Paris [*P. brevicaule* (Brid.) Beauv.] On moist soil. Not common. Calhoun, Colbert, Mobile, and Tuscaloosa Counties.

Polytrichum commune (L.) Hedw. On moist acid soils. Common, in the northern half of the state. Blount, Clay, Cleburne, Covington, Jackson, Lawrence, Lee*, Marion, Morgan, Pickens, Tuscaloosa, Washington, and Winston* Counties.

Polytrichum juniperinum (Willd.) Hedw. On moist acid soils. Common in the northern part of the state. Cherokee, Franklin, Jackson, Lamar, Lawrence, Marion, and Winston Counties.

Polytrichum ohioense R. & C. On moist acid soils. Common in the northern half of the state but rare in the south. Cleburne, DeKalb, Etowah, Franklin, Jackson, Lawrence, Marion, Washington, and Winston* Counties.

Polytrichum piliferum (Schreb.) Hedw. On moist sandy soils. Rare. DeKalb and Jackson Counties.

POROTRICHACEAE

Porotrichum alleghaniense (C. Muell.) Grout. On moist rich soil under boulders and beside streams. Not common, found by the writer only in the northern mountainous part of the state. Blount, DeKalb, Franklin, Lawrence, Morgan*, and Winston* Counties.

POTTIACEAE (TORTULACEAE)

Barbula agraria Hedw. On wet limestone. Rare, with only one collection from Clarke County.

Barbula Cruegeri Sond. On wet limestone. Rare. Clarke and Dallas Counties.

Desmatodon plinthobius Sull. & Lesq. Rare. Two collections were made by the writer: Calhoun County, No. 841—on limestone and cement retaining wall surrounding the administration building on Jacksonville State Campus, with *Tortula pagorum;* No. 676—on soil overlying brick steps of farm house in Ft. Deposit, Lowndes County. Mohr (1901) reports this species from Mobile County on damp brick walls.

Gymnostomum aeruginosum Sm. on sandstone in rock shelter. Not common. Etowah, Lawrence, and Winston Counties.

Gymnostomum calcareum Nees & Hornsch. On wet limestone rocks and calcareous soils. Not common. Choctaw, Coffee, DeKalb, Lawrence, and Monroe Counties.

Gymnostomum recurvirostrum Hedw. On wet limestone rocks and calcareous soils. Not common. Choctaw, Coffee, DeKalb, Lawrence, and Monroe Counties.

Tortella humilis (Hedw.) O. E. Jenn. [*T. caespitosa* (Schw.) Limpr.] On rotten logs, base of trees, rocks and soil. Common. Bibb, Calhoun, Choctaw, Clay, Colbert, Coosa, Cullman, Dale, DeKalb, Franklin, Geneva, Henry, Lauderdale, Lawrence, Lee, Lowndes, Marion, Marshall, Morgan, Montgomery, Randolph, St. Clair, Sumter, Tuscaloosa, and Washington Counties.

Tortula pagorum (Milde) DeNot. Rare, but perhaps overlooked. One collection, JCW No. 841, on limestone and cement retaining wall surrounding the administration building on Jacksonville State Campus, Calhoun County.

Weisia controversa Hedw. [*W. viridula* (L.) Hedw.] On various substrates in open places. Very common. Autauga, Baldwin, Bibb, Blount, Calhoun, Clarke, Clay, Cleburne, Coffee, Coosa, Dale, Elmore, Geneva, Jefferson, Lauderdale, Limestone, Lowndes, Marshall, Mobile*, Montgomery, Randolph, St. Clair, Talladega, and Tuscaloosa Counties. Mohr (1901) also reported *Weisia viridula* var. *australis* Aust. from Lee County, collected by Baker and Earle.

PTYCHOMITRIACEAE

Ptychomitrium Drummondii Sull. Not uncommon, found on bark of trees. Calhoun, Greene, Macon, Monroe, and Pickens Counties.

Ptychomitrium incurvum (Muhlenb.) Sull. Common on rocks north of the Fall Line. Blount, Calhoun, Clay, Cleburne, Coosa, Cullman*, Elmore, Franklin, Marion, Morgan, St. Clair, Talladega, and Tuscaloosa Counties.

RHIZOGONIACEAE

Rhizogonium spiniforme (Hedw.) Groch. Rare in Alabama, found in a ravine in the Pocosins in Pike County in abundance, and reported from Mobile* in the Oakhill Swamp.

SPHAGNACEAE

Sphagnum compactum DC. (*S. rigidum* Schimp.) On wet humus, overlying wet sandstone. Common in northern part of the state. Cherokee, DeKalb, Franklin, Jackson, Lawrence, Morgan*, Tuscaloosa, and Walker Counties.

Sphagnum cuspidatum Ehrh. (*S. virginianum* Warnst., *S. Faxonii* Warnst.) Harvill (No. 6830) collected this species on the ground in a swamp on the eastern end of Dauphin Island on sandy soil in a forest of *Pinus caribeae*. Mohr lists it as "floating in springs and ponds over the state," but lists only one county, Mobile.

Sphagnum cyclophyllum Sull. & Lesq. (*S. alabamae* Warnst.) Collected by Lesquereux on wet sandy ground in the Raccoon Mountains, and by Harvill on wet humus at the base of rotten stump in Mobile County.

Sphagnum erythrocalyx Hampe. (*S. guadalupense* Schimp., *S. ludovicianum* Warnst.) Sandy logs, humus on rocks at waterfall. Not common. Choctaw, Mobile*, and Washington Counties.

Sphagnum imbricatum Hornsch. (*S. Austini* Sull.) Wet humus near streams and in wet open pastures. Common. Lee*, Marion, Mobile*, Jackson, Walker, Washington, and Winston Counties.

Sphagnum imbricatum var. *affine* (Ren. & Card.) Warnst. (*S. affine* Ren. & Card.) On wet humus, banks of streams. Not uncommon. Blount, Clay, Dale, and Marion Counties.

Sphagnum macrophyllum Bernh. (*S. floridanum* Card.) Only one collection (Harvill, No. 6840). This was found growing at the base of *Nyssa biflora* in a gum swamp on the eastern end of Dauphin Island.

Sphagnum palustre L. (*S. Cymbifolium* Ehrh.) Wet humus in bogs. Common. Bibb, Coffee, Jackson, Monroe, and Winston Counties.

Sphagnum subsecundum Nees (*S. auriculatum* Schimp., *S. laricinum* Spruce, *S. mobilense* Warnst., *S. orlandense* Warnst., *S. inundatum* Russow., *S. louisianae* Warnst.) On wet humus, common north of the Fall Line. Blount, DeKalb, Jackson, Mobile*, Morgan, Pickens, St. Clair, and Winston Counties.

Sphagnum tabulare Sull. (*S. molle* Sull.) Base of hemlock at Kinlock Falls in southwest corner of Lawrence County (Harvill, No. 5813) and Mobile* County.

TETRAPHIDACEAE

Thelia asprella Sull. On bark, at base of trees. Not uncommon. Cleburne, Covington, DeKalb, Jackson, Marshall, Pike, and St. Clair Counties.

Thelia hivtella (Hedw.) Sull. On bark, at base of trees. Not uncommon. Butler, Clay, Cleburne, Conecuh, Covington, Franklin, Houston, Lamar, Lauderdale, Lawrence, Marion, Marengo, Russell, and Talladega Counties.

Thelia Lescurii Sull. On dry sandy soil. Infrequent. Autauga, Chambers, Cleburne, Covington, Lauderdale, and Pike Counties.

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ABSTRACTS

The Scientific Method as Presented in Science Textbooks and as Described by Eminent Scientists

Ernest D. Riggsby

Troy State College

Many commentators have contended that significant differences exist among the definitions of scientific method presented by textbook writers, scientists, and philosophers. This study was designed to identify areas of contrast and agreement between the definitions of scientific method in science textbooks and that contained in the writings of scientists.

A stratified random sample of contemporary school science textbooks was selected. The elements and descriptions of scientific methodology were identified in each text. A categorized random sample of eminent scientists was chosen and the description(s) of scientific method were isolated from each of their writings. Correspondence from the scientists was used to validate the scientists' current position regarding the interpretation and description of scientific methodology. The differences and similarities between the two sets of descriptions were identified.

To facilitate clarification and comparison of agreement and disagreement, a set of reference elements (*causation, classification, consensus, experimentation,* and *observation*) was isolated from the classical (authoritatively accepted) literature. Among the writers of this "reference" literature were: Campbell, Cohen, Hanson, Hull, Montague, Nagel, and Wolf.

The study included an analysis between and within these groups: the reference literature, the writings of scientists, and the textbook presentations.

The reported findings were:

1. Definitions of the five reference elements were substantially agreed upon in the reference literature.

2. Within the textbooks, significant agreement concerning definitions of *experimentation* and *observation* was identified. Inferred agreement in defining *causation* was noted. In the classical (conventional) sense, definitions of both *consensus* and *classification* were in agreement. *Classification,* in the sense of the ordering of know-

ledge, was not used in the textbooks. *Classification,* defined as the taxonomy of the realia of science, was agreed upon.

3. Significant diversity regarding *causation* and *classification,* but agreement on definition of *experimentation* and *observation,* was noted in the scientists' writings. From this category, discussions of *consensus* were omitted.

4. Between textbooks and the reference literature, there was: agreement in interpreting *experimentation* and *observation;* inferred agreement with respect to *consensus;* inferred agreement for definitions of both *causation* and *classification,* in the older, more conventional interpretations; and omission of textbook references to the more recent interpretations of both *causation* and *classification.*

5. *Experimentation* and *observation* were both defined between textbooks and scientists' writings.

6. Between scientists' writings and the reference literature, agreement (though not complete agreement) was discovered in the definitions for: *experimentation, observation, classification* (only in the sense of ordering knowledge), and *causation* (only when viewed as multiple causes, not simple single-cause, single-effect).

7. The rigidity of definitions in textbooks contrasted strongly with the descriptions of scientists. The static nature of methodology found in textbook presentations is opposed to the dynamic, evolutionary nature of scientific method as described by scientists.

Spirit in a Universe of Science

Leo B. Roberts

Montgomery, Alabama

Too long have many scientists attempted to ignore, if not to attack or to deride religion. It is beside the point that many religious leaders have, likewise, denied the validity of the findings of science. Although it is obvious that two irreconcilable systems cannot both be true, it is not necessarily true that science and religion are irreconcilable.

Whether most (or any) religious leaders make an effort towards a better understanding of science, scientists must recognize religion, or the tendency thereto, as a part of man's inheritance. They must recognize whatever spirit and spiritual forces there be as a part of man's environment, and they must make some effort towards evaluating them. A first step in that direction is a recognition that there may be something in the universe besides matter and energy—in other words, a recognition of the existence, or at least the possible existence, of spirit.

It is my considered opinion that the universe is pervaded by a Triune Entity—Matter, Energy, and Spirit; that these are one, and that the fundamental member of the trinity is spirit; for of spirit, and spirit only, are both matter and energy composed. I confidently predict that when scientists truly seek to learn about spirit in the universe and approach the task humbly and with methods and tools adapted to the purpose, then will they break through to hitherto undreamed-of knowledge.

Neither a scientist nor a theologian has the whole of truth in even his own restricted sphere. Finite mind cannot hope to fully comprehend the infinite; but there are great vistas of knowledge waiting to be explored when men make a sincere effort and adopt a suitable approach.

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The Challenge Of The Century*

WERNHER VON BRAUN
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Huntsville, Alabama

The study of history has always interested me because of the insight it gives for understanding current events and observing trends that affect the future. As a youth I read a great deal about the United States. And after coming to this country in 1945, I redoubled my efforts to learn all I could about the history and growth of America, the warmth and ingenuity of Americans, and just what makes this big democracy tick.

The people of America have encountered hardships and faced numerous challenges and opportunities in the past. Today I want to talk to you about a Twentieth Century challenge that confronts America—and the world.

First, let me draw a thumbnail sketch of America as several commentators saw it and wrote about it from 1900 to 1950. This was a turbulent period in the United States. The first half of the century was marked by amazing technological advances, but it was also filled with peaks and valleys of turmoil and stalemate, by world wars and major depressions. The national mood was erratic, also. Sometimes the people were inspired by noble goals. And again they seemed to drift aimlessly, without purpose. Especially during the depression years a paralysis seemed to grip the nation.

For more than 400 years the history of this nation had been crammed with adventure and excitement and marked by expansion. Compared with Europe, Africa, and Asia, America was the New World. Its pioneer settlers were daring, energetic, and self-reliant. They were challenged by the promise of unexplored and unsettled territory, and stimulated by the urge to conquer these vast new frontiers.

After the last geographical frontier was closed in this century many thoughtful national leaders feared that America lost the fresh, confident outlook of youth. And some pessimistic historians wrote that it would never come again, for there were no more frontiers to challenge the pioneering spirit.

Walter Lippman, dean of American columnists, commented a few years ago that the United States seemed to be a nation that had run its course, reached its objective, and was drifting aimlessly, with no strong sense of purpose.

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* Address delivered before joint session of the Alabama Academy of Science and Junior Academy, Florence State College, Florence, Alabama, April 3, 1965.

There were no more frontiers to conquer. Americans were no longer a pioneering people, Mr. Lippman said.

A Texas historian, Dr. Walter Webb, bemoaned the passing of the pioneer era in 1952 when he wrote:

"The period is about over, the loom is about full, the tapestry of an epoch is almost finished. The imagination cannot play any more with the mystery and uncertainty of a half-known world, for there is no such thing. The map is finished, the roads are surveyed, and all the paths to that kind of adventure are plainly marked and tended. The end of an age is always touched with sadness for those who lived it and those who loved it. The people are going to miss the frontier more than words can express. For four centuries they heard it call, listened to its promises, and bet their lives and fortunes on its outcome. It calls no more, and regardless of how they bend their ears for its faint whisper, they cannot hear the suggestion of a promise."

As Dr. Webb was writing these lines, men were firing rockets just a few hundred miles to the east, at White Sands, New Mexico. As the vapor trails of these rockets streaked high above the earth they heralded the first attempts to pioneer the new, unlimited frontier. The V-2's and early American rockets launched from White Sands were the ancestors of the powerful space launch vehicles of today. Rocket technology was advanced tremendously under the impetus of World War II, but its true destiny is not in the destruction of mankind, but in the exploration of space. The rocket engine, operating on the principle of Newton's third law of motion, allows man to leave the earth which has held him since his creation. Today the rocket is a roadway to the stars. Its development has ushered in the challenge of the century – the exploration of space.

Arthur C. Clarke, well-known British science writer, said recently: "The road to the stars has been discovered none too soon. Civilization cannot exist without new frontiers; it needs them both physically and spiritually."

I agree with the last part of Mr. Clarke's statement, but not altogether with the first sentence. The principles of rocketry are not new. Rockets were known 3,000 years B.C. Chinese used rockets for fireworks displays. In 1232 A.D., Ogdai, son of Genghis Khan, used "arrows of flying fire" at the Battle of Piem King. The ancient Greeks also experimented with powder and rockets. The Greeks discovered that charcoal, sulphur, and salt peter could be combined for the quick release of energy. It has been said that this powder has had more influence on history than any other powder — except, of course, face powder.

It was not until the Twentieth Century, however, that the American Goddard, the German Oberth, and the Russian Tsiolkovsky combined ancient rocket principles with modern science. It was the science and technology of our century that lifted rockets from the role of fireworks displays and flaming arrows to efficient, accurate, and dependable space transportation systems.

There has been more scientific and technical progress since 1900 than in all the previous centuries of history. And the tempo of that technological progress is speeding up every day.

For example, the Wright Brothers introduced powered airplane flight at Kitty Hawk, N.C., in 1903. It took almost 40 years to push flying speeds up to 500 miles an hour. But it took less than 15 years to go from 500 miles an hour to 17,500 miles an hour, the speed at which our astronauts orbit the earth.

The reason for this stepped-up march of science and technology is simple. It's research. Let's compare the nation's total investment in research and development last year with that in 1938, before World War II began. In 1938 the combined federal and private investment in research and development was roughly a quarter of a billion dollars. In 1964 it was more than 20 billion dollars. That is an eighty-fold increase. And more than two-thirds of the increase occurred within the past ten years.

As research has increased, the cycle from research and development to engineering to industrial application for profit has been drawn tighter. The resulting changes have come so swiftly that men and institutions have had difficulty adjusting to them. We are not merely living in changing times. We're in a revolution. According to most historians, it is the third revolution in America. Just as the eighteenth century was the period of American political revolution, and the nineteenth century one of industrial revolution, the twentieth century has brought a scientific revolution. And the third revolution will possibly influence the course of our nation even more profoundly than the other two.

The quest for new and fundamental knowledge has indeed led our civilization, based on science and technology, into an age of fantastic discoveries and high adventure. We must continue this search, which is leading us deeper into the exploration of space.

"We cannot understand the origin and evolution of life itself," a molecular biologist testified before a joint Congressional Committee last month, "until we understand the origin and evolution of our universe."

As our explorations of the moon, the sun, and the stars continue, we hope to find more clues to this intriguing mystery.

Although the Space Age is less than eight years of age, the achievements made during its infancy have been impressive. Men have circled the earth at 17,500 miles per hour and returned safely through the searing heat of re-entry. Hundreds of unmanned scientific satellites have been launched into earth orbit, and probes are being made of the moon, Mars, and Venus.

Do these space exploits seem like miracles to you? There is a general tendency to place space exploration in a world of its own, high above the plane of everyday happenings, and even beyond the comprehension of the average citizen. This is a misconception. Let me show you why these achievements are really not so miraculous, after all.

The world of space exploration is a world of accumulated knowledge, which is true of all science. It is not a house of magic or mystery. The events of the Space Age have not sprung from sudden flashes of brilliance by eccentric scientists. They have resulted from slow, painstaking efforts to unveil knowledge that has not been disclosed by inquiries of the past, and a determination to apply these new principles and techniques with the highest craftsmanship that our technology will allow.

Our progress is based on the accomplishments of our predecessors. We stand so high in space today because we stand on the shoulders of such men as Goddard, Oberth, and Tsiolkovsky, whom I mentioned earlier. And thousands of scientists and engineers in aerospace activities have added to the growing capability in space which we are developing for the nation. We are drawing from practically every scientific discipline in the book.

Achievements in space may appear spectacular and breathtaking to those who have not kept abreast of the day-by-day progress of science and technology.

I think the general public, the non-scientific community, has an obligation to try to keep up with the progress of science. Laymen should become familiar with the tools of science, understand its problems, share in its aspirations, and appreciate the relevance of the progress of science to modern living. And this includes space exploration, which is fundamentally a research and development program.

The rapid pace of science and technology forces a fast pace of life in all phases of our society. Changes are introduced into our political, military, economic, educational, and religious thought. Keeping informed generally on these changes is difficult for the layman. Historian Arnold Toynbee has said that this rapid pace of life is one of the most disagreeable aspects of our civilization.

And if keeping informed generally is difficult for the layman, imagine the task of professional people in staying abreast of the advance of knowledge in specialized fields. Take the engineering field, for instance. Someone has said that today's graduate engineer has a half life of about ten years. In other words, half of what he knows will be obsolete in a decade. And that means that he must replace this outmoded information with worthwhile new knowledge. He faces a constant task of study and learning, for half of what he will need to know ten years from now is not available to him today.

I have seen teachers in our public schools who seem over-awed with the march of science, and the space program. They throw up their hands and say, "It's beyond me." Sometimes they may even think that some of their pupils are taking part in a conspiracy to dumbfound and confuse them.

A great many young people are fascinated by the challenge of space exploration. These teen-age space buffs follow avidly the program aspects of such projects as Gemini, Apollo, TIROS, Syncom, Ranger, and Mariner.

I would be willing to wager that more than one teacher in Alabama was greeted last week by one of his students with some question like this: "Say, teacher, did you hear Gus Grissom and John Young describe their launch by a Titan II and three-orbit journey in the Molly Brown?" If the teacher can't discuss the latest exploit in space intelligently, he is promptly labeled some sort of earthbound cube by the space buffs.

These youngsters are excited by the challenge of space, and may be planning vaguely for some sort of career in the aerospace field. And there will be plenty of opportunities for them, for the aerospace industry is the largest in the United States, employing more people than the automotive industry.

In this little fictional episode there is one thing that the students — and sometimes the teachers — overlook. The teacher has the power to give the student the basic skills and tools that he will need for this career. Even if he is an English teacher.

Teen-age students who yearn for a career in rocketry or the nation's space program should realize that thorough training in the basic subjects of mathematics, science, and English is the first step on a long road to a successful career. Everything else that he learns can be added to this fundamental training like building blocks to a solid foundation.

Our twentieth century scientific revolution is based on a union of science and craftsmanship. The discoveries of science, its principles and theories, have little meaning until they are accepted by the people, put into use, and become a part of our society. The engineer and technician work together to design and build the marvelous computers, communications systems, rockets and spacecraft that are products of our age. Furthering this union of science and craftsmanship is a task for our research and educational institutions.

Space Age research has resulted in new materials, new manufacturing and testing techniques. New jobs and new skills are called for to meet tougher quality and reliability requirements. The result is increased career opportunities for young people. More and more highly trained people are needed, not only in space-related activities, but throughout all industry, which is rapidly putting to use the new technology.

The State of Alabama is in an enviable position to accept the challenge of the century. We are right in the middle of the assault on space. The Marshall Center at Huntsville is NASA's largest field installation.

Alabama ranks Number 1 in the nation in football. I'd like to see it rank Number 1 in the nation's space program. The state's greatest potential for realizing this goal is its human resources, its people. Although a great deal of progress has been made in recent years, we have a long way to go to develop these resources fully. I have followed with a great deal of interest the growth of Alabama's research capabilities in several private industries and institutions, sparked by the Marshall Center and the Army's Missile Command at Huntsville. And the emphasis now being placed on school construction, pay raises for teachers, and the expansion of vocational technical schools and junior colleges deserves the highest praise.

While some of Alabama's achievements in the Space Age have been outstanding, there are other areas in which the outlook isn't so progressive. We in this audience can make this admission, and examine the situation constructively, for we are Alabamians. As conscientious citizens, we naturally want our entire state to be progressive in all areas.

Our Twentieth Century civilization is based on science and technology. And in Alabama today we have quite a gap between science and technology and society. This is not unusual, except for the size of the gap, and the urgency for closing it. Advances in science and technology have always spread into economic, political, educational, and cultural areas. The result has always been change in habits, customs, and ways of doing things. Sometimes the changes come slowly. At other times they are cataclysmic.

One of the greatest problems facing Alabamians today is this adjustment to change. There is much to be done to bring the benefits of our Space Age science and technology to all our people, to give everyone a chance to share them equally.

Your organization can play an important part in closing the gap between science and society in Alabama. I hope you will use your influence to help all Alabamians adapt to Twentieth Century changes. I hope you will help to make all Alabamians aware of the challenge of the century – the exploration of space. To take part in this exploration is to take part in history during one of its greatest forward leaps.

Strip Mining And Soil And Water Conservation In Alabama And Georgia

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Alabama and Georgia's most important natural resources are water, minerals, soil and timber. Mineral deposits are not replaceable, but in these states timber, water and soil resources can be replenished in relatively short periods of time with proper care. Conservation of these four is much closer related than is generally realized.

The two states have similar mineral resources. Iron ore, limestone, coal, and oil are produced in large quantity in Alabama; clay and crushed stone are the chief products in Georgia. Both states have commercial deposits of many other minerals and rocks.

Soil Conservation. In the major strip mining areas of the two states, iron ore and bauxite mining in southeast Alabama and southwest Georgia, coal and iron ore mining in north Alabama and northwest Georgia, and iron ore and coal mining in central Alabama, new attention is being focused on the unsightly piles (dumps) of soil, sand, clay, shale, gravel or sandstone which are stripped to recover valuable minerals. What good or what harm has been done to the land by stripping? Is it economically feasible to reclaim, that is, to smooth the surface to its former shape? Should the mining company, which pays a royalty to the landowner, be responsible for reclaiming or should this responsibility be the landowner's? These are some of the questions raised in considering the problem of soil conservation by reclaiming land after strip mining.

The general public is greatly interested in reclamation of stripped land in large farming and timber areas. Small clay, sand and gravel pits and limestone, dolomite and marble quarries rarely cover large enough areas to affect soil conservation practices in any given area.

In the southeast-Alabama southwest-Georgia iron ore area in Barbour, Pike, Crenshaw and Butler Counties, Alabama, and Stewart and Webster Counties, Georgia, large areas have been, and probably will continue to be, stripped for brown iron ore. Since 1954 mining has added millions of dollars to the economy of the area.

In some areas, reclaimed land is actually superior to former land for growing trees and pastures. Examples of such lands that were mined, reclaimed and planted in pines are parts of the Walter Bass property 1 mile north of Brundidge, Alabama, the Ed. H. Rogers property, 4 miles east of Columbia, Alabama, and the Providence Canyon area in Stewart County, Georgia. Examples of reclaimed land sown in pasture are the Joe Carlisle property 6 miles west of Brundidge, Alabama, and properties 3½ miles west of Brundidge and properties 5 miles east of Greenville, Alabama.

There are four principal reasons why this is true. First, in stripping overburden to a depth of 40 feet or more (typical soil zones rarely exceed 3 feet deep) such unweathered nutrients as potash, phosphate, iron, manganese, sulfur and lime-rich minerals are brought to the surface. Reclaiming redistributes these nutrients over the surface. Because these minerals are not as soluble as those in commercial fertilizers, they require more time to weather at the surface to enrich the soil. Second, because layers of sand, clayey sand and clay are thoroughly mixed in stripping and reclaiming, a poor soil with too much sand or too much clay or which is extensively gullied can be improved by replacing or filling it with the sand and clay mixture. Third, where the brown iron ore bed is shallow, thick, and well-cemented, barriers to tree root growth can be expected. This is believed to affect pine trees by causing less vertical and more horizontal treetop growth, thus generally stunting the tree. (Personal communication, George W. Peake, President, Georgia Forestry Association). Therefore, removal of this ore bed by mining allows deeper and easier penetration of roots and more normal tree development. Fourth, mining of areas of extensive outcrops and removal of iron ore boulders makes cultivation easier.

As far as the economics of reclaiming stripped land in southeast Alabama and southwest Georgia are concerned, reclaiming costs have been estimated to be from $40 to $60 per acre (1). Costs are lowered if land is reclaimed while mining progresses. Indeed, if defined areas were mined and reclaimed systematically, probably only one growing season would be lost. Unfortunately, up to the present time, the market for southeast-Alabama southwest-Georgia brown iron ore has not been large enough or consistent enough to allow systematic mining and reclaiming or to allow research on new methods of efficient mining and reclaiming.

Royalty payments to the landowner are 25 to 50 cents per long ton in southeast Alabama and southwest Georgia (1), compared to a standard of 25 cents per long ton in other brown iron ore areas in the southeast U.S. The miner's profit margin is very low, not allowing the miner to absorb the cost of reclaiming.

It would be to the landowner's advantage to reclaim stripped land by agreement with the miner by forfeiting a small fraction of the royalty payment. Mining would not only pay high returns to the landowner in royalties but might even improve the land for growing trees and pasture. The principal disadvantage would be the loss of the use of the land for that period of time required for mining and reclaiming. It is essential that the landowner be willing to pay a fraction of the royalty for reclaiming and for the miner to develop the cheapest and quickest method of reclaiming to satisfy the landowner and the general public, if the large deposits of brown iron ore now known to exist in southeast Alabama and southwest Georgia are to be completely developed.

In the brown iron ore and coal mining areas of northwest Alabama in Franklin, Marion, Fayette and Walker Counties, and coal mining areas of northwest Georgia in Dade and Walker Counties, reclaiming land after strip mining is not as feasible as in southeast Alabama and southwest Georgia. Most of the land stripped is hilly timber land and is not prime farming land. Stripping is generally more costly because of the character of the stripped material, which is usually sandstone, conglomerate or shale. These rocks are not moved easily nor do they break up rapidly to form new soil. Strangely enough, in this area timber seems to grow as rapidly on old strip pit dumps as on reclaimed land. Accessibility to unreclaimed coal stripping areas for timber cutting may be somewhat limited by the presence of strip pits and dumps.

The brown and red iron ore and coal strip-mining areas in central Alabama in Tuscaloosa and Jefferson Counties have similar reclaiming problems to that in the northwestern parts of Alabama and Georgia. Material stripped is usually sandstone, shale, limestone or conglomerate and is difficult and costly to move particularly in areas where stripping is deeper than 40 feet. In many of the stripping areas of northwestern Alabama and Georgia and central Alabama, coal and iron ore strip-mine reclaiming is not economically feasible for the miner or landowner.

Each strip mine area is a problem in itself and should be studied carefully before any conclusions can be reached on the advisibility of reclaiming. General laws applying to strip mining statewide may apply to one area but would not be workable in another area.

Water Conservation. Most of the major strip mining operations in Alabama and Georgia use water for washing impurities out of ore. In the southeast-Alabama southwest-Georgia brown iron ore area the water source usually is a creek, a dammed branch or more rarely a pumped well. Water is pumped to a log washer where it mixes with the grains and lumps of ore, sand, and clay, which, when agitated by the log paddles in a trough, scrubs and cleans the ore. After screening, the water, mixed with fine ore, sand, and clay, is discharged into settling ponds where most of the fine ore, sand and clay settles out and the water runs off through normal drainage channels.

Some of the overflow is cloudy, but the clay and iron oxides carried by water will not harm fish or wildlife or cause excessive silting of streams. The U.S. Study Commission, Southeast River Basins (2) reported no stream pollution in 1960 along Pigeon Creek in Butler County, Alabama, along Pea River in Barbour County, Alabama, along Whitewater Creek above the confluence with Mims Creek in Pike County, Alabama, or along streams draining the Stewart-Webster County, Georgia, area. These streams were the principal drainage channels for most of the brown iron ore washing operations in 1960 in southeast Alabama and southwest Georgia. Stream pollution was reported on Mims Creek in Pike County, Patsaliga Creek in Crenshaw County, and Persimmon Creek in Butler County. These polluted areas were all immediately downstream from towns which had no municipal treatment or septic tanks for waste discharges. This shows the necessity for thorough study (not just the evidence of the color of streams) to isolate the exact polluting agents. Eyesore mining operations may not be the principal source of stream pollution, despite its appearance.

Most of the accidental mudding of streams by brown ore washers is similar to the runoff from heavy rains on cultivated fields. Runoff from cultivated fields may contain small amounts of fertilizer and insecticides as well as sand and clay, while the log washer effluent has no major chemical contaminants except red and brown iron oxides and manganese oxides, which are very noticeable, but are not considered a health hazard to man.

With normal care in the use of settling ponds, water from brown iron ore washers in southeast Alabama and southwest Georgia is not a major cause of polluting streams.

After mining, the landowner usually is left with one nice fishpond and one or more pits that make good watering holes for livestock.

In the brown iron ore and coal washing areas in northwest Alabama, the problems of strip mining and water conservation are not solved easily. Each mine is a special problem and detailed hydrologic and geologic studies are needed to determine the effect and extent of any mine or washing plant effluent which enters drainage channels.

What harm does washed coal effluent do to streams in sparsely populated areas? What is the acidity of the effluent nearby and farther downstream from a washing plant? How long and how far is a coal slurry carried in a stream of slight or considerable flow? What would be the cost of completely preventing coal contamination in minor streams near coal washing plants? If laws are passed to require a high degree of water purity in coal and iron ore areas, would many mines have to close because of the extra cost of operation?

If major mining industries are shut down through punitive and compensatory damage claims brought about by strict rules of water use, will the resultant water conditions compensate for the reduced economy of an area?

These and other questions must be answered before it can be determined what are the most important uses for water in any given area.

The author would like to propose a solution to the extreme views of some conservationists and some industrialists. This solution would be to set aside certain bodies of water to be used for recreational and wildlife uses and other bodies of water to be used principally for transportation and industrial uses. The use for these areas would be selected only after thorough mineral resource and other studies to determine the future industrial development potential of the area. The industrial-use water would have less stringent requirements for purity and turbidity than that for recreational use, but industrial use water (large, dammed lakes of major rivers) could be used to recharge ground-water supplies. In other words, major rivers used for industrial and transportation uses would serve as an indirect supply of ground water and the recreational lakes would serve as direct supplies of surface water. This proposal would require that the industrial water be of such a condition that a reasonable thickness of overlying rock would act as an effective filter for impurities while recharging the ground-water supplies. Limestone areas with extensive solution channelways would have to receive special study because the thickness of the overlying rock would not necessarily provide an effective filter.

This proposal assumes that efforts will be made to keep Alabama and Georgia's water as clean as possible and still encourage industrial use, paying particular attention to providing for adequate future supplies of ground and surface water for residential and municipal use.

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The Basis And Applications Of Cruising Timber With A Wedge Prism

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I. Introduction

In 1948 Walter Bitterlich, a forest engineer in Salzburg, Austria, made a discovery that is presently revolutionizing the art of timber cruising. Mr. Bitterlich's angle gauge, a forerunner of the modern wedge prism, enabled the timber cruiser to remain at the plot center while tallying the sample trees rather than measuring individual tree diameters and plot boundaries. At the onset of this new method only the basal area per acre could be derived, but further experimentation by L. R. Grosenbaugh, of the Southern Forest Experiment Station of the U.S. Forest Service, led to methods of estimating volume per acre, growth, and number of trees of different species or sizes. With the advent of these new discoveries the use of the prism, or similar instruments, increased in scope until today the majority of the large timber holding companies depend largely on this method for their forest information, and the small operators are gradually exploring the prism's possibilities and putting them to use. A new method of cruising that saves time, expense, and personnel has been accepted by the forestry profession.

II. The Basis of Prism Cruising

Mr. Bitterlich's angle gauge is a relatively simple device consisting of a 33 inch stick with a peephole mounted on one end and a one inch crosspiece on the other. The angle created by constructing a line from the peephole to each side of the crosspiece is 104.18 minutes. Any tree whose diameter, when viewed through the peephole, appears greater than the width of the crosspiece is counted. Since the 104.18 minute angle is constant, the ratio of tree diameter to distance from the plot center is also constant. For example, a tree one foot in diameter and thirty-three feet from the plot center viewed through the peephole will exactly cover the crosspiece. The same will hold true for a two foot diameter tree at sixty-six feet from the plot center. This constant ratio is the basis for determining the basal area factor. Since the basal area factor for a 104.18 minute angle gauge or 3.03 diopter prism is 10, each tree tallied represents ten square feet of basal area per acre. This can be explained using the same diameter trees as before for an example. If the basal area of the one foot diameter tree is calculated it will give $\Pi/4\ (1)^2$ square feet, and if the area of the plot is calculated it gives $\Pi/4\ (66)^2$ square feet. The tree then will occupy $(1/66)^2$, or 1/4356, of the area of the plot. Since a plot which contains 4356 square feet covers 1/10 of an acre, one tree that is counted represents 10 when the data are put on a per acre basis. This "blow-up" factor is the so-called "basal area factor" used in this type of cruising. For a two foot diameter tree the ratio is $(2/132)^2$, which also reduces to 1/4356 and again the basal area factor is 10. From this reasoning it can be seen that each tree counted under these circumstances contributes 10 square feet to the total basal area per acre. From this it can be determined that the plot size is directly related to the dbh of the tree, and the plot radius easily calculated by multiplying the tree diameter in feet by 33. Also it can be concluded that no tree more than thirty-three times its diameter in feet from the sampling point will be tallied. To determine the basal area per acre, simply multiply the number of trees tallied on a plot by the basal acre factor. If more than one plot is used, the basal area per acre is calculated by dividing the total number of trees tallied by the total number of sampling points and then multiplying by the basal area factor.

Of primary importance in cruising with a prism is the fact that the area cruised varies with the different tree diameter classes. The smaller the tree diameter the smaller the land area on which the trees are tallied, and vice-versa. This is an important factor in the time element of cruising. Since most foresters agree that a large percent cruise is not necessary in the smaller diameter classes for an accurate volume estimate, little is sacrificed and the cost per acre cruised is greatly reduced.

III. Applications of Prism Cruising

No changes in the conventional sampling procedures need be made when the prism is used. Of course the number of lines and sampling points will vary with the intensity of individual cruises, but general procedure remains the same. The sampling point replaces the center of fixed-area sample plots.

A. **Tree count:** Marginal trees

One reason for the speed and accuracy of prism cruising is the fact that most of the trees viewed are clearly "in" or "out". When a tree appears marginal when viewed through a prism the cruiser should measure the dbh of the tree and the distance from the point center to the center of the tree. If the diameter of the tree in feet times 33, or the diameter in inches times 2.75, exactly equals the measured distance to the tree, then the tree is marginal and should be tallied as one-half the volume of that particular size tree. If the calculated distance is less than the measured distance the tree is "out", but if the calculated distance is greater than the measured distance the tree is "in" and should be tallied.

B. Slope Correction:

Slope adjustment must be made whenever 10% or more slope is present on a sample plot. Where slope is present, the line of sight to the breast height of a tree will be along the hypotenuse of a right triangle instead of along the horizontal leg. Consequently, the distance from the prism to the tree will be longer than it should be and marginal and near marginal trees will be excluded from the tally. The correction for this error can easily be made by holding the prism perpendicular to the line of sight, rotating the prism clockwise around the line of sight to exactly the angle formed between the line of sight and the horizontal, and then viewing the tree. This correction can be made most easily with the help of an Abney level. First the level is sighted on the breast height of the tree and the level bubble is centered. The indicator arm is then locked in place. The flat bottom edge of the prism is placed on the flat top surface of the Abney level tube, beyond the level bubble mount, and the level turned sideways and rotated until the leveling bubble is centered. The tree is then viewed through the prism as previously described.

C. Other Factors Affecting Precision:

1. **Prism Position:** The prism must be held over the point center when viewing a tree. This means that the cruiser must circle around the prism instead of remaining on the plot center and swinging the prism around himself. For this reason cruisers usually carry a point center stake to use as a guide for prism position.

2. **Hidden Trees:** Often the cruiser will encounter plots which have trees behind trees or trees behind vines or brush. When this occurs he must exercise care to remain the same distance from the tree when he moves to a position to view it as he was at the point center. In brushy country it sometimes is possible to determine whether a tree is "in" or "out", without cutting the brush, by viewing the tree above the brush. If a tree viewed at this angle is marginal or "in" then it should be tallied since the distance to the tree

is increased and the diameter is decreased. If the tree viewed at this angle appears "out", brush cutting may be necessary.

Occasionally, especially in bottom lands, a tree may have large vines attached to its bole in such a position as to make the tree appear larger in dbh than it really is. When viewed through the prism the tree may appear to be "in", but in actuality it may be "out" or marginal. Care on the part of the cruiser will eliminate errors of this type.

D. **The Cruise Sheet:** Tree Tally

Most companies now employing the prism as a method of cruising require that trees be tallied by species, approximate diameter class, and merchantable height. Since the board foot volume in the larger diameter classes plays an important role in the logging costs of a timber sale, it is important to know what percentage of total volume is in various diameter classes. In hardwood sales, the volume by species is as important in determining stumpage price as the volume by diameter class is in determining logging costs. Diameters and heights are not measured, but the cruiser makes occasional checks to verify the accuracy of his estimates.

If the cruise is an intensive one for management purposes, the cruiser may use separate tally sheets for each plot. In this way he can collect various data such as site, amount of reproduction present, dominant species, average age of stand, ground cover, topography, live crown ratio, and vigor. If, on the other hand, the cruise is made for volume only the cruiser may only use as many tally sheets as there are condition classes, keeping a running total of sample points in each class. Generally, the type of cruise governs the number of tally sheets and data gathered.

E. **Office Procedure:** Volume Determination

Various methods have evolved for determining volume from data gathered on a prism cruise. An explanation of one simple, efficient method will be attempted here.

First, the tree tally must be made by diameter class and merchantable height. Then, number of trees by diameter class and number of trees by merchantable height within each diameter class must be tabulated. Next the volume of each diameter and height class, from an appropriate volume table, must be multiplied by the corresponding number of trees. This will give the volume per diameter class.

Since a different area is cruised for each diameter class it is necessary to calculate the area cruised for each. This is done by computing the area of the circle in which a particular diameter class is tallied, then multiplying the total number of plots by this area. Since each diameter class will have a different plot radius this step must be repeated for each diameter class.

Once the volume cruised and the area cruised in each diameter class has been determined, the volume per acre by diameter class can be calculated by dividing the number of acres cruised into the total volume in each diameter class.

After this step, it is a simple matter to multiply the total acres in the tract by the volume per acre of each diameter class to get the total volume by diameter classes on the tract.

F. Conclusion: The prism is not the answer to a cruiser's dream, for the legwork is not eliminated, but it definitely has earned a place in modern forestry practice.

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Hailstorms In Alabama

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Hail may be defined: (1) as precipitation in the form of balls or irregular lumps of ice, always produced by convective clouds, nearly always *cumulonimbus*. An individual unit of hail is called a *hailstone*. By convention, hail has a diameter of 5 mm or more, while smaller particles of similar origin, formerly called "small hail", may be classed as either *ice pellets* or *snow pellets.*

Thunderstorms which are characterized by strong updrafts, large liquid water contents, large cloud-drop sizes, and great vertical height are favorable to hail formation.

The largest hailstone observed in the United States is believed to be one which fell at Potter, Nebraska, on July 6, 1928. It measured 17 inches in circumference and weighed about 1.5 pounds. In this storm, individual hailstones fell far apart, on an average about 10 to 15 feet from each other.

Extensive investigations by Hoyt Lemons (2) showed that hailstorms occur most frequently in the continental interior at middle latitudes, diminishing seaward and becoming less frequent also as they approach the equator and the poles.

Dry subtropical areas such as the regions near the Mediterranean Sea, the middle and northern Pacific coastal region of the United States, and the western coast of British Columbia have the greater part of their hail during the winter months. Humid subtropical regions, such as the southern part of the United States adjacent to the Gulf of Mexico, have a late spring and early summer maximum of hailstorms. Other inland areas in the temperate zone have the most frequent and the most severe hail in the summer months, the season when crops are most susceptible to its damage. Hailstorms are rare at low latitudes, although some subtropical regions occasionally have hail which ranks in severity with that of the middle latitudes. Hailstorms have been known to occur over large bodies of water in low latitudes.

According to Flora (3), hail is more destructive than tornadoes. A single hailstorm striking a city during business hours can in a few minutes result in a loss of a million dollars or more to parked automobiles alone. In many parts of the High Plains between the

100th meridian and the Rocky Mountains, hail destroys, on the average, 8 to 10 per cent of all crops annually.

Hailstorms at Montgomery were studied for the 30-year period, 1919-1948, and a tabulation is given below for their monthly frequency.

January	0%	July	9%
February	6%	August	0%
March	28%	September	3%
April	27%	October	0%
May	6%	November	3%
June	18%	December	0%

It is interesting to note that no hailstorms were recorded during the months of January, August, October, and December. A much longer period of record would undoubtedly have shown hailstorm occurrences during these months, even though rarely. It is also interesting to note that 55 per cent of the hailstorms at Montgomery occurred during the months of March and April, being almost equally divided between the two months.

A study was also made as to the diurnal frequency of hailstorms at Montgomery, by 6-hourly periods of the 30-year period, 1919-1948, and the results are tabulated below.

Midnight to 6 a.m.	6%	Noon to 6 p.m.	67%
6 a.m. to Noon	15%	6 p.m. to Midnight	12%

About two-thirds of the hailstorms occurred during the afternoon, or between noon and 6 p.m., while only 6 per cent occurred between midnight and 6 a.m.

Perhaps one of the worst hailstorms in Alabama occurred on May 22, 1928, in Pickens and parts of neighboring counties. The heaviest hail fell in a strip some 3 miles wide and 40 miles long, extending from southwest to northeast diagonally across Pickens County into southern Fayette County. The largest hailstones were the size of baseballs, and in places the hail drifted as much as 8 feet deep. Many chickens and some livestock were killed. About 22,000 acres of crops were ruined; trees were stripped of leaves and branches and, in some cases, killed.

According to Flora (3) hail risk in Alabama is among the lowest risks prevailing anywhere in the country, but there have been a few heavy losses from individual storms.

The Glossary of Meteorology (1) states that the size of hailstones usually ranges from that of a pea to that of a grapefruit, i.e., from less than one-fourth of an inch to more than 5 inches in diameter.

Fortunately, most of the hailstorms in Alabama are more or less local, with small hail falling for only a few minutes, causing very little damage. Occasionally, however, hailstorms will cover several counties, with rather large hail, causing severe damage.

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(3) Flora, S. D., Hailstorms of the United States. University of Oklahoma Press, Norman, Okla. 1956.

ABSTRACTS

Physics And Mathematics

Some Concepts About Programming a Determinant

D. A. KLIP
University of Alabama Medical Center
Birmingham, Alabama

The standard method of programming the determinant of a square matrix is the Gauss elimination method, which reduces a square matrix to one which contains zeros below the main diagonal.

However, in some respects and certainly in case the matrix is "sparse" (i.e. it has many zeros) it is advantageous with respect to the round-off error to compute the determinant directly from its definition as the sum of its n! terms, if n is not too large. It has been shown how this can be programmed in Fortran II for a specific order of the matrix and in Fortran IV for any order and in which way from the regularity of the subsequent terms found with the aid of DO-loops, a rule for the signs of the terms can be derived. For higher order than say order 6 and also for lower order in case of routine purposes the Laplace expansion, which calculates the determinant as a sum of products of lower order determinants, is preferable.

As an illustration a 3 x 3 determinant has been calculated manually with the Gauss method and according to one of the above mentioned programs. (This work was supported by a PHS Research Grant H5379.)

Design and Construction of a Cryostat for Measuring The Hall Effect from 80°K to 600°K

DAVID COFFEY and LYNDA ARNOLD
Physics Department, Auburn University
Auburn, Alabama

A cryostat has been designed and constructed for use in the measurement of Hall voltages of thin films over the temperature range from 80°K to 600°K. Details of the design are reported along with complete discussion of the problems of fabrication.

Electrical Properties of Weakly Ionized Gases

R. F. ASKEW, L. L. INGRAM, and T. H. KAO
Physics Department, Auburn University
Auburn, Alabama

Studies have been made on the conductivity of a weakly ionized nitrogen plasma. Also the radial distribution of the current density has been determined for a cylindrically symmetric nitrogen plasma.

Data have been obtained over the pressure range from 0.1 Torr to 1.0 Torr. The radial dependence of the current density is constant to within 10% when the region of the plasma is filled with the normal glow discharge. For pressures above 0.5 Torr the distribution has a sharp minimum in the central region. This region is also void of a visible glow.

The conductivity has been found to vary with both pressure and current. These values will be presented.

PROGRAM

FORTY-SECOND ANNUAL MEETING

OF THE

Alabama Academy

OF

Science

THE

Alabama Junior Academy of Science

AND

Gorgas Scholarship Foundation

April 2-3, 1965

FLORENCE STATE COLLEGE
Florence, Alabama

PROGRAM
of the
GORGAS SCHOLARSHIP FOUNDATION
Thursday, April 1

(Selection of winners of Alabama State Science Talent Search for General Gorgas Scholarships.)

3:00-5:00 P.M. — Registration .... Room 100, Science Building
5:00 P.M. — Demonstration of Exhibits to Judges .... Room 200, Science Building
6:30 P.M. — Banquet for Gorgas Finalist and Judges .... Turtle Point Country Club
8:00 P.M. — Personal interviews of Finalists by Judges .... Second Floor, Science Building

(Awards will be presented at the Joint Banquet of the Senior and Junior Academies of Science, Friday, April 2 at 7:30 P.M., Great Hall, Student Union Building.)

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PROGRAM
of the
ALABAMA JUNIOR ACADEMY OF SCIENCE
Friday, April 2

8:00 A.M.-12 Noon — Registration .... Lobby, Student Union Building
8:00 A.M.-10:00 A.M. — Preparation of Exhibits .... Second Floor, Science Building
10:00 A.M. — Caucus of officers and official delegates .... Room 102, Science Building
— Conference of sponsors and counselors .... Room 213, Science Building
10:45 A.M. — Business Meeting .... Education Auditorium
12:00 Noon — Luncheon for AJAS Executive Committee .... B C Rooms, Student Union Building
— Lunch available for members and sponsors .... Great Hall, Florence State College and Commercial Restaurants
12:30 P.M. — Meeting of AJAS Executive Committee .... B C Rooms, Student Union Building
1:30 P.M. — Joint General Session and Business Session, AAS and AJAS .... Education Auditorium
2:30 P.M. — Section Meetings of the Alabama Academy of Science. (Junior Academy members are encouraged to attend one of these meetings.)
— Tours conducted by F.S.C. Conservation Club and Student ACS groups.
3:00 P.M. — Judging of Exhibits .... Second Floor, Science Building
7:30 P.M. — Joint Banquet for Alabama Academy of Science and Alabama Junior Academy of Science — Great Hall, Student Union Building
9:00-11:00 P.M. — Junior Academy Party — Dance and Hootenanny .... Education Auditorium

PROGRAM
of the
ALABAMA JUNIOR ACADEMY OF SCIENCE
Saturday, April 3

8:00 A.M.-12:00 Noon — Exhibits on Display........Science Building
— Group Exhibits........Room 212
— Individual Exhibits........Rooms 206 and 208
8:00 A.M. — General Assembly for presentation of scientific papers by AJAS Regional Finalists........Education Auditorium
9:00 A.M. — Business Meeting........Education Auditorium
10:30 A.M. — Joint Meeting of Alabama Academy of Science and Alabama Junior Academy of Science........Appleby Junior High School Auditorium
12:00 Noon — Dutch Treat Luncheon for old and new Executive Committee Members........B C Rooms, Student Union Building
12:00-4:00 P.M. — Remove Exhibits.

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PROGRAM
of the
ALABAMA ACADEMY OF SCIENCE
Thursday, April 1

(All meetings will be held on the Florence State College Campus.)

6:00 P.M. — Dutch Dinner for members of the Executive Committee and Guests........Town & Country Room, Holiday Inn
7:30 P.M. — Executive Committee Meeting, open to members........Town & Country Room, Holiday Inn

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Friday, April 2

8:00 A.M. — Registration........Outside Foyer, Science Building
9:00 A.M.-12:00 Noon — Section Meetings
- I. Biological Sciences........Room 100, Science Building
- II. Chemistry........Room 203, Science Building
- III. Geology and Anthropology
  - Geology Session........Room 303, Science Building
  - Anthropology Session........Room 217, Science Building
- IV. Forestry, Geography and Conservation........Room 201, Science Building
- V. Physics and Mathematics........Room 319, Science Building
- VI. Industry and Economics........Room 221, Science Building
- VII. Science Education........Room 301, Science Building
- VIII. Social Sciences........Room 225, Science Building

1:30 P.M. — Joint General Session and Business Session, AAS and AJAS........Education Auditorium
2:30 P.M. — Section Meetings
- I. Biological Sciences........Room 100, Science Building

III. Geology and Anthropology
  Geology Session .... Room 303, Science Building
  Anthropology Session .... Room 217, Science Building
IV. Forestry, Geography and Conservation .... Room 201, Science Building
V. Physics and Mathematics .... Room 319, Science Building
VI. Industry and Economics .... Room 221, Science Building
VIII. Social Sciences .... Room 225, Science Building
IX. Medical Sciences .... Room 213, Science Building

4:00-5:30 P.M. — Junior Academy of Science Exhibits open to Academy members and the public .... Second Floor, Science Building

4:30 P.M. — Conference of Participants in NSF Grant Programs .... Room 203, Science Building

7:30 P.M. — Joint Banquet of Junior and Senior Academies .... Great Hall, Student Union Building,
Host: E. H. Sargent and Company

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Saturday, April 3

8:00 A.M.-12:00 Noon — Exhibits of Alabama Junior Academy of Science open to Academy members .... Second Floor, Science Building

8:00 A.M. — Section Meetings
I. Biological Sciences .... Room 100, Science Building
II. Chemistry .... Room 203, Science Building
III. Geology and Anthropology, Geology Session .... Room 303, Science Building
V. Physics and Mathematics .... Room 319, Science Building
VI. Industry and Economics .... Room 221, Science Building
VIII. Social Sciences .... Room 225, Science Building
IX. Medical Sciences .... Room 213, Science Building

10:30 A.M. — General Session with Alabama Junior Academy of Science .... Appleby Junior High School Auditorium

— Address: Dr. Wernher von Braun, Director, George C. Marshall Space Flight Center, Huntsville, Alabama. Topic will be "The Challenge of the Century."

— Presentation of Awards — R. V. Miles, Jr., Trustee

— AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
  Boy and Girl Recipient — A. Frederic Hemphill

— ALABAMA JUNIOR ACADEMY OF SCIENCE
  Outstanding Region — G. O. Spencer

— ALABAMA ACADEMY OF SCIENCE
  Outstanding Teacher — R. E. Wheeler
  Undergraduate Research — Urban L. Diener
  Graduate Research — Urban L. Diener

12:00 Noon — Adjourn

EXHIBITS

Exhibits associated with the Alabama State Science Talent Search for General Gorgas Scholarships........Room 200, Science Building

Exhibits in competition between the Regional Science Fair Winners........Second Floor, Science Building

Exhibits in group competition between Alabama Junior Academy of Science Clubs........Second Floor, Science Building

Commercial........Engineering Drawing Laboratory

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SECTION PROGRAMS

ALABAMA ACADEMY OF SCIENCE

9:00 A.M., Friday, April 2
Section I, Biological Sciences
Room 100, Science Building
David J. Cotter, Vice-President

1. **Biochemical Fuel Cells. (15 min.)**
   John W. Hansen, John W. Hansen Floral Services Co.
2. **The Effect of Magnesium on the Growth and Morphology of Arthrobacter globiformis in Simple Chemically-defined Media. (10 min.)**
   Rebecca Wolfgang and Margaret Green, University of Alabama.
3. **Studies on the Fishes of the Tallapoosa River System in Alabama and Georgia. (15 min.)**
   James David Williams, University of Alabama

*4. **Fishes from Limestone Springs of the Valley and Ridge Provine of Mobile Basin. (15 min.)**
   Richard D. Caldwell, University of Alabama

5. **Aspergillus Crown Rot of Peanuts in Alabama. (12 min.)**
   James A. Lyle, Auburn University.
6. **Effect of Crop Rotation on Soil Fungi Populations as Determined by the Immersion Tube Technique. (12 min.)**
   Robert T. Gudauskas*** and James A. Lyle, Auburn University.
7. **Business Meeting. Report of Nominating Committee.**
   Jack S. Moore.
8. **Further Studies on the Electrophysiology of Taste in the Honey Bee. (15 min.)**
   Kamal S. Yacksan*** and Leland C. Clark, University of Alabama Medical Center.
9. **The Possibilities of Telemetry in Biological Research. (15 min.)**
   J. R. Howes, Auburn University.
10. **Controlled Environmental Chambers for Avian Research — Some New Concepts. (15 min.)**
    W. Grubb***, C. A. Rollo, and J. R. Howes, Auburn University.
11. **The Fate of Insoluble Grit in the Avian Alimentary Tract as Determined by X-rays. (15 min.)**
    H. Hollingsworth***, J. R. Howes, and J. Geary, Auburn University.

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* This paper is an entry for the graduate student research award.
*** Person delivering paper.

SECTION II, CHEMISTRY

Room 203, Science Building
Francis J. Kearley, Jr., Vice-President

1. **Models and Comments on the Properties of the Nucleons. (10 min.)**
   Bernard Rovatti, Druid City Hospital.
2. **Polydispersity of Hyaluronic Acid in Synovial Fluid. (20 min.)**
   L. S. Hazlegrove, William Niedermeier, and D. F. Smith, University of Alabama.
3. **Preparation of Oxamide from Formamide. (15 min.)**
   Richard C. Sheridan, Division of Chemical Development, Tennessee Valley Authority.
4. **Structure and Fertilizer Value of Organic Nitrogen Compounds. (20 min.)**
   Raymond E. Isbell, Division of Chemical Development, Tennessee Valley Authority.
5. **A Spectrophotometric Study of the Niobium (V)-m-Cresotic Acid Coordination Complex. (15 min.)**
   James E. Norris and James E. Land, Auburn University.
6. **Chemistry in a New Venture in Creative Learning. (20 min.)**
   A. G. Hill, Mobile College.
7. **Determination of Effluent Tritium from Electron Capture Detectors Used in Gas Chromatography. (15 min.)**
   Thomas Mitchell Moore and Harold Zallen, Auburn University.
8. **Experimental Procedures in Polymer Chemistry. (20 min.)**
   Harold Zallen, Auburn University.
   Business Meeting. (15 min.)

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SECTION III, GEOLOGY AND ANTHROPOLOGY (GEOLOGY SESSION)

Room 303, Science Building
Thomas A. Simpson, Vice-Chairman

1. **Sulfide Mineralization in the Cragford District, Clay and Randolph Counties, Alabama. (20 min.)**
   Thornton L. Neathery, Alabama Geological Survey.
2. **Economic Geology of the Moon – a pessimistic View. (15 min.)**
   Robert D. Deininger, University of Alabama.
3. **Possible Correlation of Coal Beds on Sand and Lookout Mountains. (20 min.)**
   Reynold Q. Shotts, University of Alabama.
4. **Surinam Geology Notes. (15 min.)**
   Thomas A. Simpson, Alabama Geological Survey.
5. **The Ouachita influence on Mississippian facies in Alabama. (20 min.)**
   William A. Thomas, Birmingham-Southern College.

*6. **Structural Geology of the Blount Springs Inlier, Blount County, Alabama, (15 min.)**
   M. Michael Pitts, Jr., University of Alabama.
   Business Meeting (Geology and Anthropology) (10 min.)

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* This paper is an entry for the graduate student research award.

ALABAMA GEOLOGICAL SOCIETY LUNCHEON — Holiday Inn, 12:30-1:30 p.m.
(Slides of Piedmont Field Trip — Annual Election of Officers.)

SECTION III, GEOLOGY AND ANTHROPOLOGY
(ANTHROPOLOGY SESSION)

Room 217, Science Building
Paul H. Nesbitt, Vice-President

1. **The Pre-ceramic Horizon of Certain Bluff Shelters in the Sand Mountain Area of the Tennessee Valley in Alabama. (15 min.)**
   David L. DeJarnette and Margaret V. Clayton, University of Alabama.
2. **Some Ceramic and Projectile Point Associations in the Tennessee Valley. (15 min.)**
   Joseph L. Benthall, Tuscaloosa.
3. **Preliminary Consideration of Burials from the Liddell Site, Wilcox Co., Alabama. (10 min.)**
   John William Cottier, University of Alabama.
4. **A Ceramic Sequence in Central Alabama Prehistory as seen to date. (15 min.)**
   David W. Chase, Montgomery Museum of Fine Arts, Montgomery.
   Business Meeting. (Geology and Anthropology) (10 min.)

SECTION IV, FORESTRY, GEOGRAPHY AND CONSERVATION

Room 201, Science Building
Glendon W. Smalley, Vice-President

SYMPOSIUM

Resources and their Development in the Tennessee River Watershed of Alabama

1. **The Tennessee River Valley in Alabama: Its Geographical Setting. (20 min.)**
   Jesse M. Richardson, Auburn University.
2. **Soil Resources in the Tennessee River Watershed of Alabama. (20 min.)**
   Joe B. Dixon, Auburn University.
3. **Forest Resource of North Alabama. (20 min.)**
   John H. Hinton, Tennessee Valley Authority.

Intermission

4. **Agricultural Development in the Tennessee Valley Portion of North Alabama. (30 min.)**
   Gerald G. Williams, Tennessee Valley Authority.
5. **Mineral Resources of the Southeast — Important Components for the Future Development of our Nation (With special Reference to the Tennessee River Valley of Northern Alabama.) (20 min.)**
   Philip E. LaMoreaux, Geological Survey of Alabama.
   Business Meeting. (20 min.)

SECTION V, PHYSICS AND MATHEMATICS

Room 319, Science Building
E. L. Robinson, Vice-President

1. **Spectrophotometry of Chloroplast Suspensions. (10 min.)**
   Donald Byrd, John R. Watts, and Paul Latimer, Auburn University.

2. **Dynamic Interactions of the Solid State by the Mossbauer Effect. (15 min.)**
   Romas A. Shatas, U.S. Army Missile Command.
3. **Matteucci Effect: Its Interpretation and Its Use for the Study of Ferromagnetic Matter. (35 min.)**
   Roman Skorski, University of Alabama.
   Business Meeting.

SECTION VI, INDUSTRY AND ECONOMICS

Room 221, Science Building
Frank E. Dykema, Vice-Chairman

1. **Methodology of the Study of Economic Theory. (15 min.)**
   Thomas E. Holland, University of Alabama.
2. **Adjustment in Size of Milk Producers: A Markov Process Analysis. (15 min.)**
   Lowell E. Wilson, Auburn University.
3. **The Status of the Economic Education Movement in Alabama. (7 min.)**
   John Hollie Allen, Florence State College.
4. **Applications of the Deductible in Planning an Individual's Insurance Program. (15 min.)**
   Robert Hatfield Stretcher, Jr., Auburn University.
5. **Labor Conditions in the Lumber Industry in Alabama 1880-1914. (25 min.)**
   Richard W. Massey, Jr., Birmingham-Southern College.
6. **The Economic Contribution of Florence State College to the Surrounding Community. (15 min.)**
   William S. Stewart, Florence State College.
   Business Meeting.

SECTION VII, SCIENCE EDUCATION

Room 301, Science Building
Richard O. Tatum, Vice-Chairman, Presiding

Part I

1. **The Laboratory Report. (15 min.)**
   Ernest D. Riggsby, Troy State College.
2. **Science Demonstrations: Success or Failure? (10 min.)**
   Dutchie S. Riggsby, Troy Junior High School.
3. **A Functional Program for the Preparation of Secondary School Science Teachers. (20 min.)**
   Joseph C. Thomas, Florence State College.
4. **Business Meeting. (5 min.)**

Part II

Panel Report: **Emerging Programs in the Teaching of Pre-College Science. (Panel members are consultants participating in the current AAS-NSF Cooperative College-School Science Program.)**

Moderator: **R. E. Wheeler, Director, AAS-NSF Cooperative Program, Howard College.**

1. **Mathematics. (15 min.)**
   W. L. Furman, S.J., Spring Hill College.

2. **Biology. (15 min).**
   Eldon J. Cairns, Auburn University.
3. **Physics. (15 min.)**
   William T. Wilks, Troy State College.
4. **Chemistry. (15 min.)**
   R. H. Dinius, Auburn University.
5. **General Discussion led by secondary school teachers who have worked with the consultant group.**
   Alton Till (Mathematics), Evergreen High School.
   Gladys Cowart (Biology), Charles Henderson High School, Troy.
   Joe Baker (Physics), Enterprise High School.
   Don Chitwood (Chemistry), Lawrence County High School, Moulton.

SECTION VIII, SOCIAL SCIENCES

Room 225, Science Building
Charles G. Summersell, Vice-President

1. **Federalism and Environmental Charge.**
   Walter H. Bennett, University of Alabama.
2. **Kossuth's Liberation From Turkey in 1851.**
   Sandor Szilassy, Library, Auburn University.
3. **The DUD in Livingston, Alabama.**
   D. P. Culp, University of Alabama.

*4. **Leaders and Non-leaders — A study of Role Change in Children's Groups Composed of All Leaders and All Non-leaders.**
   Mrs. Emily Strong, University of Alabama.
   Business Meeting.

2:30 P.M., Friday, April 2

SECTION I, BIOLOGICAL SCIENCES

Room 100, Science Building
David J. Cotter, Vice-President

1. **Effects of Atrazine on Sclerotium rolfsii and Trichoderma viride. (15 min.)**
   E. A. Curl*** and H. H. Funderburk, Auburn University.

*2. **Influence of Biotic Soil Factors on the Behavior of Fomes annosus. (12 min.)**
   Walter D. Kelley, Auburn University.

3. **Some Characteristics of a New-Inbred Strain of Laboratory Mice. (15 min.)**
   Paul C. Bailey, Birmingham-Southern College.
4. **The Blood Picture in a Leukemic Strain of Laboratory Mice. (10 min.)**
   Terry Cosper*** and Tommy Wells, Birmingham-Southern College.
5. **Flourometric Analysis of Intestinal Serotin before and after Blockade. (15 min.)**
   Don Kimbrough and Kenneth Ottis, Auburn University.
6. **Studies on Calorigenesis in the White Rat. (15 min.)**
   Ruth Lanier and Kenneth Ottis, Auburn University.

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* This paper is an entry for the Graduate student research award.
*** Person delivering paper.

7. **Biosynthesis, Storage, and Release of Intestinal Serotonin in the White Rat. (15 min.)**
Ann Forster and Kenneth Ottis, Auburn University.

8. **Revegetation at the Briarfield Furnaces. (10 min.)**
David J. Cotter, Alabama College.

*9. **Influence of Nitrogen on Aflatoxin Synthesis by Aspergillus flavus in an Artificial Medium. (12 min.)**
David W. Eldridge, Department of Botany & Plant Pathology, Auburn University.

SECTION III, GEOLOGY AND ANTHROPOLOGY (GEOLOGY SESSION)

Room 303, Science Building
Thomas A. Simpson, Vice-Chairman

1. **Deformational Variation Across Strike in the Mississippian Sandstone-shale Sequence of the Southern-most Appalachians. (15 min.)
Harry W. Mueler, Birmingham-Southern College.

2. **Pea Ridge — Does it Preserve "Fossil" Stratigraphy? (20 min.)**
Reynold Q. Shotts, University of Alabama.

3. **Chromium Enrichment in Hydrated Iron Oxide Sediments, Southeastern Alabama. (15 min.)**
W. Everett Smith, Alabama Geological Survey.

4. **Concretions of Organic Origin in the Brewer Phyllite. (15 min.)
Dennis Burdick, Birmingham-Southern College.

5. **Geology of the Waterloo Tripoli District. (15 min.)**
Otis M. Clarke, Jr., Alabama Geological Survey.

6. **Consistent Geologic Map and Isopleth Patterns of the Upper Mississippian in the Bean Creek Area, Tennessee. (15 min.)**
C. C. Ferguson and R. G. Stearns, Tennessee Division of Geology.

SECTION III, GEOLOGY AND ANTHROPOLOGY (ANTHROPOLOGY SESSION)

Room 217, Science Building
Paul H. Nesbitt, Vice-President

1. **Changing Ojibwa Kinship: Parallels to the Southeastern United States. (15 min.)**
J. G. E. Smith, University of Alabama.

2. **Cherokee Acculturation: A Folk-Urban Study in Historical Perspective. (15 min.)**
Roy S. Dickens, Jr., University of Alabama.

3. **Migrant Work Society: Mobile Social Compatibility. (15 min.)**
Allyn G. Spence, University of Alabama.

SECTION IV, FORESTRY, GEOGRAPHY AND CONSERVATION

Room 201, Science Building
Jesse M. Richardson, Vice-Chairman

1. **Recreational Use of Valley Resources. (15 min.)**
Lawrence H. Marks, Alabama Department of Conservation.

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* This paper is an entry for the Graduate student research award.
** This paper is an entry for undergraduate student research award.

2. **TVA Power Program and Its Relation to North Alabama. (20 min.)**
   W. D. Thompson, Tennessee Valley Authority.
3. **Industrial Development and Its Effect on the Growth Patterns of Urban Centers in the Tennessee River Valley. (30 min.)**
   Merle Sherman, Florence State College.
4. **Integrating Resource Development — the Bear Creek Watershed Program, an Example. (30 min.)**
   Frank H. Moses, Tennessee Valley Authority.

SECTION V, PHYSICS AND MATHEMATICS

Room 319, Science Building

E. L. Robinson, Vice-President

1. **Some Considerations of Experimental Hypervelocity Research. (10 min.)**
   W. C. Hull, Hayes International Corporation.
2. **Problem Area in Shaped Charge Design. (15 min.)**
   Ned D. Gilliam, Hayes International Corporation.
3. **Design and Construction of a Cryostat for Measuring the Hall Effect from 80°K to 600°K (10 min.)**
   David Coffey and Linda Arnold, Auburn University.
4. **Vapor Pressure of Liquid Nitrogen. (10 min.)**
   J. W. Cook, J. T. Johnson, and R. F. Askew, Auburn University.
5. **Electrical Properties of Weakly Ionized Gases. (10 min.)**
   R. F. Askew, L. L. Ingram, and T. H. Kao, Auburn University.
6. **Design Considerations for a High Current Hemispherieal Cathode. (20 min.)**
   James E. Horn, Southern Research Institute.
7. **The 8,000 KW Plasma Facility at Redstone Arsenal. (15 min.)**
   Thomas A. Barr, Jr., U.S. Army Missile Command, Redstone Arsenal.
8. **Mathematics in Jesuit Seminaries. (10 min.)**
   W. L. Furman, Spring Hill College.

SECTION VI, INDUSTRY AND ECONOMICS

Room 221, Science Building

H. Ellsworth Steele, Vice-President

1. **The Economic Theory of Industrial Development. (25 min.)**
   L. B. Dickson, Alabama State Chamber of Commerce.
2. **Concepts of Economic Development as Applied to North Alabama. (20 min.)**
   Roger C. Woodworth, Tennessee Valley Authority.
3. **Industrial Development in Alabama. (20 min.)**
   G. Thornton Nelson, Alabama Power Company.
4. **Anticipation of Economic Development: Considerations in Provision of Adequate Telephone Service. (20 min.)**
   Carl T. Happer, Jr., Southern Bell Telephone and Telegraph Company.
5. **A Low-Cost Method for Identifying Local Industrial-Development Opportunities Applied to Birmingham, Alabama. (25 min.)**
   William C. Duckworth and Sheldon Schaffer, Southern Research Institute.

SECTION VIII, SOCIAL SCIENCES

Room 225, Science Building
Charles G. Summersell, Vice-President

1. **James Anthony Froude: Historian of the Tudor Age.**
   Bernerd C. Weber, University of Alabama.
2. **Discipline in a Distinguished Old Alabama Church, 1865-1890.**
   George V. Irons, Birmingham.
3. **Prototype for a Nation: The Establishment of the Alabama Department of Archives and History in 1901.**
   James F. Doster, University of Alabama.
4. **Execution of the Mexia Prisoners (Tampico, Mexico, December 1835).**
   Raymond Estep, Maxwell AFB, Montgomery.

SECTION IX, MEDICAL SCIENCE

Room 213, Science Building
H. H. Schnitzlein, Vice-President

1. **Parameters Affected by Anytal in the in vitro Rana pipiens Gastric Mucosa. (15 min.)**
   Richard L. Shoemaker, University of Alabama Medical Center.
2. **Therapeutic effect of Cortisone in Magnesium-Deficient Rats. (15 min.)**
   Daniel R. Farnell, Auburn University.
3. **A Possible Correlation Between Eccrine Sweat Chloride Values and Respiratory Disease in Naval Recruits. (15 min.)**
   Terrance L. Myers, Troy State College.
4. **Preliminary Study of Modifications in the Cultural Environment Effecting Hemolysis in Blood Agar Plates by Streptococci. (15 min.)**
   Jeanne Louise Wright and Mildred A. Engelbrecht, University of Alabama.
5. **Effects of Host Weight Loss Upon Friend Leukemia Virus Infections in Mice. (15 min.)**
   Charlotte Maxwell, Robert W. Sidwell, Sara M. Sellers, and Glen J. Dixon, Southern Research Institute.
6. **The Antiviral Effect of Cycloheximide. (15 min.)**
   Gussie Arnett and Glen J. Dixon, Southern Research Institute.
7. **Potentiation of Ionizing Radiation by Selected Purine Analogs on Cultured Mammalian Cells. (15 min.)**
   Margaret M. Blackwell and Glen J. Dixon, Southern Research Institute.
8. **Studies on the Persistence of Vaccinia Virus on Fabrics. (15 min.)**
   Louise Westbrook, Glen J. Dixon, Robert W. Sidwell, and Ethel McNeil, Southern Research Institute.
9. **Aaron Lopez. (10 min.)**
   Emmett B. Carmichael, University of Alabama Medical Center.

8:30 A.M., Saturday, April 3

SECTION I, BIOLOGICAL SCIENCES

Room 100, Science Building
David J. Cotter, Vice-President

The Undergraduate Biology Curriculum, William K. Stephenson, Earlham College; representative from the Commission on Undergraduate Education in the Biological Sciences (CUEBS). (30 min.)

Discussion. (45 min.) Panel members: William Blow, Athens College; J. C. O'Kelley, University of Alabama; Kenneth Ottis, Auburn University; and, Henry Turner, Alabama College.

8:00 A.M. Saturday, April 3

SECTION II, CHEMISTRY

Room 203, Science Building

Francis J. Kearley, Jr., Vice-President

1. **The ACS Student Affiliate Chapter at Birmingham-Southern College. (15 min.)**
   W. R. Mountcastle, Jr., Birmingham-Southern College.
2. ****Identification of Fe(III)-di-sec-butyl Phenylphosphate Complex. (15 min.)**
   James B. Nabors, Jr., Birmingham-Southern College.
3. ****Solubility Studies of the Fe(III)-di-sec-butyl Phenylphosphate Complex. (15 min.)**
   Delbert H. Miles, Birmingham-Southern College.
4. ****Evaluation of the Sargent Model IV Polarograph, Micro Range Extender, and I. R. Compensator. Applications to the Determination of Fe(III) in Solvent Extraction Procedures. (15 min.)**
   Jerry T. LeBlanc, Birmingham-Southern College.

SECTION III, GEOLOGY AND ANTHROPOLOGY (GEOLOGY SESSION)

Room 303, Science Building

Thomas A. Simpson, Vice-Chairman

8:00 A.M. — Geological Field Trip (participants furnish own vehicles).
Start — Florence State College.
End — Russellville brown iron ore mines, U.S. Pipe & Foundry Co.
Field trip leader — Jack E. Morris, U.S. Pipe & Foundry Co.

SECTION V, PHYSICS AND MATHEMATICS

Room 319, Science Building

E. L. Robinson, Vice-President

1. **Sliding Pulse Versus Conventional Pulse Height Analyzers. (15 min.)**
   Billy Wayne Speller and Harold Zallen, Auburn University.
2. **Techniques of Analysis Utilizing and Sliding Pulse Analyzer System. (15 min.)**
   Billy Wayne Speller and Harold Zallen, Auburn University.
3. **Determination of Density Changes in a Moving Fluid Using Bremsstrahlung Radiation. (15 min.)**
   Carl Blackstone Smith, Harold Zallen and Allen Ray Barbin, Auburn University.
4. **Carburization of Steel in Liquid Hydrocarbons. (30 min.)**
   Roman Skorski, University of Alabama.

** This paper is an entry for the undergraduate student research award.

SECTION VI, INDUSTRY AND ECONOMICS

Room 221, Science Building
H. Ellsworth Steele, Vice-President

1. History of Charge Account Banking with Emphasis on the Sixth Federal Reserve District. (20 min.)
   Mrs. Charles Woodley, Auburn City Board of Education.
2. The Structure of Commercial Banking in Alabama. (20 min.)
   William D. Geer, Howard College.
3. The Economic Impact of Agricultural and Industrial Development in a Six-County Area. (15 min.)
   Bill Miller, Auburn University.
4. A Central City and the Economic and Social Impact of Interstate Highways — Birmingham, Ala. (30 min.)
   Charles Thomas Moore and Morris L. Mayer, University of Alabama.
5. Changing Age Composition of Tennessee Valley Farmers and Its Effects on Future Farm Numbers. (20 min.)
   James G. Dillard, Tennessee Valley Authority.

SECTION VIII, SOCIAL SCIENCES

Room 225, Science Building
Charles G. Summersell, Vice-President

1. A Benedictine Monk in the Confederate Chaplains Corp. . . . The Only Confederate Catholic Chaplain Killed on the Battlefield.
   Father Aloysius Plaisance, OSB
2. The Western Boundary of the Comanche Indians with Special Reference to the Royce Map in the 18th Annual Report of the BAW.
   A. B. Thomas, University of Alabama.
3. Spanish Military Commanders in Colonial Alabama.
   Jack D. L. Holmes, University of Alabama.
4. Suggested Inventory Control Procedures for Alabama Wholesalers.
   Lyndon E. Dawson, Jr., The Citadel, Charleston, S.C.
5. Halfway Houses for Released Offenders.
   Alan J. Shields, Auburn University.

SECTION IX, MEDICAL SCIENCES

Room 213, Science Building
H. N. Schnitzlein, Vice-President

1. A Description of the Development of the Facial Muscles in Man. (15 min.)
   Raymond F. Gasser, University of Alabama Medical Center.
2. Some Cortical Efferent Pathways of the Opossum. (15 min.)
   George F. Martin, Jr., University of Alabama Medical Center.
3. The Nature of the Heart Dipole. (15 min.)
   Willem Klip, University of Alabama Medical Center.
4. Isolation and Characterization of a Line of H. Ep. #2 Cells Resistant to 2-Fluoroadenine. (15 min.)
   Margaret H. Vail and L. L. Bennett, Jr., Southern Research Institute.
5. Richard Fraser Michel. (15 min.)
   Emmett B. Carmichael, University of Alabama Medical Center.

Annual Business Meeting

FLORENCE STATE COLLEGE
April 2, 1965

The meeting was called to order by President Barrett at 1:37 p.m. Members of the Alabama Junior Academy of Science were in attendance.

Dr. Turner Allen, Academic Dean of Florence State College was introduced by the President. Dr. Allen welcomed the Alabama Academy of Science and the Alabama Junior Academy of Science to the campus of Florence State College. He expressed regrets on behalf of Dr. E. B. Norton, President of Florence State College, who was unable to attend because of pressing business at the State Capitol. Dr. Allen emphasized the significance of the impact that the Academy and its members have on scientific developments.

The President reported that the minutes of the 1964 Annual Meeting were mailed to the membership in mimeographed form and asked for any corrections.

252. Motion by Yancey, seconded by Feazel that the 1964 minutes of the Business Meeting be approved. Motion passed unanimously.

The President called for reports from selected officers and committee chairmen.

REPORT OF THE SECRETARY (DeVall). Registration at this the Forty-second Annual Meeting of the Academy has been 250. A total of 58 different agencies, institutions and organizations are represented. Registration by sections has been as follows:

I	Biological Sciences	73
II	Chemistry	31
III	Geology and Anthropology	28
IV	Forestry, Geography and Conservation	11
V	Physics and Mathematics	31
VI	Industry and Economics	14
VII	Science Education	20
VIII	Social Sciences	13
IX	Medical Sciences	10
X	Engineering	1
	Miscellaneous	18
	Total	250

Registration for the Alabama Junior Academy of Science now stands at 201.

REPORT OF THE AUDIT COMMITTEE, ALABAMA ACADEMY OF SCIENCE (Moore). The accounts of the Alabama Academy of Science were examined for the year 1964 and found to be in order.

253. Motion by Chastain, seconded by Sulzby that the report of the Audit Committee be accepted. Motion passed unanimously.

REPORT OF THE AUDIT COMMITTEE, ALABAMA JUNIOR ACADEMY OF SCIENCE (Wilks). The records of the Alabama Junior Academy of Science were reviewed and found to be in order.

PLACE OF MEETING COMMITTEE (Bailey). The Executive Committee accepted the invitation of Birmingham-Southern College to hold the annual meeting on its campus, April 1-2, 1966 and recommended that the Academy approve this action.

254. Motion by Bailey, seconded by Lyle that the invitation of Birmingham-Southern College be accepted. Motion passed unanimously.

It was further reported that the Executive Committee had accepted the invitation of the University Center, Huntsville, Alabama to hold the 1967 Annual Meeting in its facilities. The exact dates will be determined and reported to the Executive Committee at its Fall 1965 meeting.

255. Motion by Bailey, seconded by Furman that the invitation from the University Center at Huntsville be accepted and that the Committee on Place of Meeting make plans toward holding the 1967 meeting at Huntsville, Alabama. Motion passed unanimously.

REPORT OF THE DIRECTOR, NATIONAL SCIENCE FOUNDATION VISITING SCIENTIST PROGRAM (WHEELER). A grant of $11,500 from the National Science Foundation made possible 336 visits by scientists to high schools and to various teacher groups. The largest number of visits was made in the field of mathematics. Twenty-two visits had been made in connection with the program of the Alabama Junior Academy of Science. An invitation was extended to members to indicate their desire to participate and, therefore, increase the number of persons listed on the roster beyond the current level of 90. A second grant of $10,500 enabled the Alabama Academy of Science to support a Cooperative College-High School Science Program for the teachers of Alabama.

REPORT OF THE PERMANENT COUNSELOR OF THE ALABAMA JUNIOR ACADEMY OF SCIENCE (SPENCER). There are 96 members in the Alabama Junior Academy of Science and the state has been divided into nine regions that correspond with the nine science fair regions. Each science group is encouraged to prepare an exhibit for group competition. The first and second place winners in each of the seven categories in the regional science fair are then invited to exhibit at the annual meeting of the Alabama Junior Academy of Science. Each region is asked to present its outstanding paper in both the biological science and the physical science fields.

The President reported that the Editor of the *Journal*, Dr. E. D. Chastain, Jr., has submitted his resignation. He commended Dr. Chastain for his diligent work to bring the *Journal* up to date and to improve its format.

NOMINATING COMMITTEE (FEAZEL). The Nominating Committee consisting of R. E. Wheeler, E. Carl Sensenig, and Charles E. Feazel, Chairman, submits the following list of nominees:

President: James F. Sulzby, Jr.
President-elect: David L. DeJarnette
Secretary: W. B. DeVall
Treasurer: John M. McKibbin[1]
Editor of Journal: Robert T. Gudauskas[2]
Councilor of the AAAS: Patrick H. Yancey, S.J.
Permanent Counselor of Junior Academy: G. O. Spencer
Coordinator of Science Fairs: George O. Twellmeyer, S.J.
Trustees: Ralph B. Draughon, Frank A. Rose

---

[1] To fill unexpired term of J. Richard Thomson.
[2] To fill unexpired term of E. D. Chastain.

(Nominees for Vice-Presidents and Vice-Chairmen of Sections are listed on the inside front cover.)

256. Motion by Carmichael, seconded by Yancey that the nominations be closed and that each person nominated for his respective office be declared elected. Motion passed unanimously.

RESOLUTIONS COMMITTEE (Lyle). Your Resolutions Committee submits the following resolutions:

1. WHEREAS the Alabama Academy of Science is successfully engaged in the Forty-Second Annual Meeting on the campus of Florence State College, therefore, be it resolved:

a) That the Academy express appreciation to the officials of Florence State College and to its President, Dr. E. B. Norton for their hospitality;

b) That special appreciation be expressed to Dr. Joseph C. Thomas, Chairman of the Local Arrangements Committee for the Senior Academy, and to Professor T. N. Hubbuch, Chairman of the Local Arrangements Committee for the Junior Academy, and their co-workers whose untiring efforts contributed in no small way to the success of the meeting;

c) That the gratitude of the Academy be expressed to Mr. H. F. Milling and the Birmingham Division of the E. H. Sargent and Company for their hospitality in providing the annual dinner.

2. WHEREAS during the past year, death has deprived the Academy of the valued services of two members; now, therefore, be it resolved that the Academy extend its sympathy to the families of PAUL J. ARNOLD and ROYCE L. MURRAY; and express its appreciation for the loyal and valuable services these members have given to the Academy.

257. Motion by Lyle, seconded by Steele that the report of the Resolutions Committee be accepted. Motion passed unanimously.

ADMISSION TO MEMBERSHIP (DeVall).

Total membership, December 31, 1963	587
Increase in membership during 1964	96
Loss in membership during 1964	27
Total membership December 31, 1964	656
Net gain in membership for 1964	69

The President reminded those in attendance that every effort should be made to suspend Saturday morning meetings in time to permit those attending to get to the auditorium were Dr. Werner von Braun will present his talk before a joint audience of the Alabama Junior Academy of Science and the Alabama Academy of Science. He expressed appreciation for the fine attendance at the 1965 meeting and for the hospitality of Florence State College and the excellent preparations made by all of its officers and committee members.

The meeting was adjourned at 2:05 p.m.

W. B. DeVall, Secretary

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OF THE

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AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

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Studies On Ecological Effects Of Short Term Exposures Of Ionizing Radiation

DAVID J. COTTER
Alabama College, Montevallo, Alabama

The science of radiation ecology may be divided into two different fields of investigation; namely, the use of radioactive isotopes and the effects of radiation. The basic utility of the first area of study resides in its novel and fundamentally sound approach to biological processes. Since the radioactive isotopes are essentially identical in biological action to their stable counterparts, they may be used to trace metabolic pathways of particular elements or labeled compounds within an organism. The use of these tracers is not confined to the individual organism, but may be used at the population, community, and even ecosystem levels to determine migratory patterns, position in food chains, trophic levels, niches, and other characteristics of organisms. Often this method is quicker and more efficient than classical approaches to these same problems.

The second aspect of radiation ecology is concerned with effects of radiation on organisms and groups of organisms. If we are ever to safely reap the rich harvest of potential power locked within the atom, we must be thoroughly familiar with the hazards that will be encountered in such endeavors. The future development of nuclear reactors with their attending production of radioactive waste products and effluents must be charted with the knowledge of the consequences of releasing radioactive materials into our environment. If nuclear reactors are to become the prime energy source of the future, surplanting the dwindling store of fossil fuels, we must begin to accumulate vast stores of information on the effects of radiation on biological systems. For more dangerous than radioactive wastes is the spectre of nuclear warfare and further contamination of the atmosphere by the testing of atomic weapons to the point that background levels due to fallout could exceed safe levels and become a hazard to man and his renewable natural resources. There arise such questions as: What are permissable levels of radiation for man and other species? What are the ecological effects which are often quite different from those obtained in the laboratory. Not only are we concerned with the effects on physiological processes, but also effects on the interactions among these processes.

There are four basic methods, with many intermediate combinations for irradiating ecosystems or their components. The methods are (1) short-term exposure from uniform radiation field (as would occur in fallout from atomic detonation) followed by recovery; (2) short-term exposure from a point source followed by recovery; (3) long-term or chronic exposure from a point source with concomitant adjustment to continued stress; and (4) direct radiation from nuclear explosion, accompanied by heat and blast, followed by recovery (Platt, 1964). This review is restricted to cover certain phases of studies which would fall under the scope of the second category. Thus the papers reviewed are concerned with only one method of exposure. It is anticipated that several worthy papers have not been included in this review. It is not meant to be an exhaustive cataloguing of all the papers in this active area of research but rather a synoptic view of some of the major developments in this somewhat restricted field of radiation ecology.

The purpose of this review is to focus attention on studies which have dealt with the effects of ionizing radiation on plant communities. The basic approach to the problems has been the consideration of radiation as another facet of the environmental complex. The initial phase of these studies attempted to establish base lines of ecological response of species and communities to different levels of radiation. These studies utilized X-radiation. Subsequent studies were expanded beyond the spatial limitation of X-ray instruments and utilized outdoor gamma irradiation facilities and mixed gamma-neutron radiation from an unshielded nuclear reactor.

The island communities on the granite outcrops near Atlanta were chosen as the ideal units for the initial studies. These are particularly appropriate for radiation studies for the following reasons:

(1) There have been a number of cytological life histories on some of the characteristic species of the outcrops: *Isoetes melanospora* (Johnson, 1938), *Diamorpha cymosa* (McCrainie, 1938), *Amphianthus pusillus* (Lunsford, 1939), *Sabulina brevifolia* (Stipe, 1939), *Talinum teretifolium* (Guptill, 1941), and *Gelsemium sempervirens* (Speer, 1942). An additional study on *Tradescantia paludosa* (Beatty, 1952) is of interest because of the plant's wide use in research of radiation effects on chromosomes. Supplementing these have been floristic studies of Stone Mountain, (Campbell, 1921 and Smith, 1938), Mount Panola (Mathews, 1941), general studies of the flora of the granite outcrops in Georgia (Baker, 1945 and 1956), and a detailed survey of phenology of forty communities on the outcrops for over a year (Burbanck and Platt, 1964). Ecological investigations of the past few years include: Wiggs (1956), Cotter (1958a and 1958b), Lammers (1958), Cotter and Platt (1959), Mc-

Cormick (1959 and 1962), Wiggs and Platt (1962), McCormick and Platt (1962), Cotter (1962 and 1963), and Dorris (1964). Studies on other granite outcrops include those of Whitehouse (1933), Oosting and Anderson (1937 and 1939), Harper (1939), McVaugh (1945), Keever, Oosting and Anderson (1951), Winterringer and Vestal (1956), and Keever (1957). Thus the ecology and floristics of the granite outcrops in general and the Southeast in particular is well known.

(2) A number of endemic and disjunct species occur on these outcrops. McVaugh (1945) states that over one third of the 44 characteristic flat-rock species are endemic to the granites.

(3) The granite outcrops are ecologically unique. Ambient temperatures on the outcrops exceed the extremes reported at the Atlanta Weather Bureau by 5 to 10° C. Moisture conditions fluctuate widely depending on rainfall, since the shallow soils over the rock surface have a low water retention. Other environmental modifications of the habitat included unique combinations of light, soil, mineral nutrition, and other conditions that are not found elsewhere in the Southeast. The geology of the area has been thoroughly investigated (Watson, 1902a and 1902b), (Herrman, 1954) and (Hopson, 1958).

(4) The granite outcrops are also characterized by low level radiation from unstable minerals, such as uranophanes, present in them (Hurst, 1955 and Furcron, 1955). The levels of the radioactivity vary from outcrop to outcrop and from habitat to habitat on the individual outcrops (McCormick and Cotter, 1964). The levels of bioaccumulation of the radionucleides vary from species to species and habitat to habitat (Cotter and May, unpublished data). Radioactive material has been present during the invasion, establishment, and evolution of the characteristic endemic species. Thus this represents one of the few instances where the effect of chronic low level radiation could be analyzed.

(5) A final important condition of the granite outcrop communities that ideally suits them for this study is their physical habitat. Since the plants grow in shallow soils on an impervious bed of granite, it is possible to insert a piece of sheet metal between the soil and the underlying granite and lift entire communities or segments of them intact and relatively undisturbed and to transfer them to the laboratory or greenhouse for various experimental treatments including radiation. (Platt and McCormick, 1964.)

In the first studies, begun in 1956, segments of the island communities were removed from their natural habitats, placed in flats and carried back to the Emory University Campus for treatment. The flats were exposed to radiation from an X-ray source three times a week for varying lengths of time until a spectrum of radiation treatments was built up, with some exposures exceeding 100,000 r (Platt and Witherspoon, 1958). These studies and those by Platt and Cotter (unpublished data) established the responses of a number of the outcrop species under experimental conditions including radiation treatments that served as base lines for further studies.

Some of the results of these first studies indicated that there was a differential response by different species to radiation. Some were stunted and eventually eliminated at different radiation levels. Certain morphological aberrations were observed and correlated to exposure level. The pattern of species elimination in response to high levels of radiation remained obvious in these flats during the year following radiation. Many species had been killed before reproduction occurred. Others which received high sub-lethal radiation prior to reproduction reflected the radiation damage by a reduction in viable seed yield which was easily observed in the second year of the study.

Exposure of these irradiated plants to environmental extremes of temperature and moisture showed a reduction in physiological tolerance correlated with the amount of radiation received.

Another ecologically significant observation was a change in successional pattern by differential elimination of certain species by the radiation. The more advanced "climax" species were found to be more susceptible to radiation, so that radiation brought about a reversion to a more primitive stage in succession.

Certain problems were encountered in conducting the above experiments. Only one X-ray unit was available, and this bottleneck caused an inordinate amount of time being spent in exposing the plants to radiation. Another problem was the physical handling of the flats. The most significant problem was the inability to expose the plants to prolonged radiation treatment under more natural conditions. The development of a cobalt field eliminated most of these problems and provided a much more satisfactory exposure technique. The Cobalt-60 source was later replaced by a stronger Cesium-137 source, which has a longer half-life, and thus provides more uniform exposures for long term experiments.

A series of minature synthetic granite outcrops were fabricated around the radioactive source. A concrete base was constructed to conform to micro-topographic variation in the natural habitat, and arranged in the shape of long throughs radiating out from the source like spokes in a wheel. Hot tar was poured over the concrete and then covered with fine granite gravel and dust. Segments of the outcrop communities where then placed in the proper position in their respective housing. The natural decrease in radiation intensity with increasing distance from the source provided a gradient in the level of radiation exposure (McCormick, 1959 and 1960).

McCormick (1963) reported both stimulatory and inhibitory effects of radiation on plant growth and survival. Typical results included stunting, early cessation in flowering, and subsequent earlier death in some species which reduced the reproductive potential available for future generations. Other species increased in density, growth rate, duration and amount of flowering, and length of life cycle with exposure to increasing amounts of radiation up to a certain level. These changes resulted in a change in the biological interrelationships of these plants. The second generation, which developed without exposure to radiation, failed to show the stimulatory effects produced in the first generation, thus establishing that the responses observed are not under genetic control.

From these studies it is apparent that radiation affects different species in different ways, and that the species composition of a community will be altered by radiation exposure. For the results of radiation studies on natural communities to be completely valid the community interaction to the radiation exposure must be evaluated.

Many other studies are anticipated at the cesium facility. Its current major usage is an ambitious analysis of the effects of radiation on the total ecosystem.

Another facet of this research was made possible by the establishment of Georgia Nuclear Laboratory at Dawsonville, Georgia. This facility, built by Lockheed Aircraft Corporation under contract to the Air Force, consists of an air-shielded nuclear reactor in a valley in the heart of a sixteen square mile reservation. The reactor has been operated intermittently by Lockheed since its completion in 1959. The broad aspects of the program were outlined by Platt and Mohrbacher (1959) and Platt (1959a, 1959b, and 1960a). The vegetation of the area was mapped (Pedigo, 1959, and Pedigo and Platt, 1959). Other important observations were made prior to radiation.

Although the ten megawatt reactor has been operated at various levels throughout its history, only two ecologically significant amounts of radiation were released, these occuring during July 1959 and August, 1960. The mixed gamma-neutron exposures to the surrounding vegetation ranged from approximately 12,000 to 15,000 rads at 500 feet to background levels at 2,000 feet for both exposures. These two exposures accounted for about 80 per cent of the total radiation released and have served as the basis for the studies done there. These two short term exposures roughly simulate the expected levels of radiation that would result following proximal fallout from atomic explosions (Platt, unpublished manuscript), and also distinguish the studies at this site from the work which has been done at Brookhaven (Sparrow and Miksche, 1961; Sparrow and Woodwell, 1963). The Brookhaven work dealing with the ecological effects of radiation (Woodwell, 1963) has been concerned more with the effects of chronic exposure to varying levels of radiation than with acute exposures. One difficulty with chronic exposures which is far more pronounced than with short term doses is the assignment of the exact radiation dose which produces an effect. In the chronic studies an effect may be induced by low levels of radiation and masked by other continuing effects or the responses may be delayed giving the impression that a higher level of radiation is required to produce an observed effect.

A general overview of the subject (Platt, 1962b, 1963a, 1963b) provides compelling reasons for the pursuance of this area of investigation as well as a list of the major objectives of the studies.

Cowan (1961) and Cowan and Platt (1963) established the radiation pattern of the mixed neutron-gamma flux which was released from the reactor by observations at 68 strategically located detector stations. This work provided the basic dosimetry for all studies conducted at the Lockheed Reactor. In addition to line of slight determination, readings were made to establish the effects of terrain and vegetation shielding and scattering effects of atmosphere, terrain, and vegetation on both neutron and gamma radiation.

Pedigo (1960 and 1963) found the lethal dose of 10 to 30 year old trees of *Pinus taeda* to be about 3-4,000 rads. Terminal growth was inhibited by about 1,000 rads. His findings indicate a relationship of radiation with auxin metabolism. The pines are one of the most radiosensitive of the tree species surrounding the reactor and are the first to be eliminated from the mixed pine-hardwood forest following radiation. Later studies by Pedigo (unpublished data) and by McCormick (1964) showed that the seedling stages are even more sensitive.

McGinnis (1960, 1962, 1963a, 1963b, and 1963c) found that the 1959 radiation which approached the lethal dose for some trees (15,000 rads) caused the initiation of litter drop seven weeks earlier in the fall than control groups, and that leaf production was almost completely inhibited in 1960. A dose of 4,000 rads caused only a week earlier litter release than non-irradiated controls, but a 42 per cent reduction of litter production in 1960.

Daniel (1960a and 1960b) investigated the effects of radiation on the old field vegetation surrounding the reactor and supplemented these studies at the cobalt-60 field on the Emory campus. He recorded changes in dominance in the typical old-field species on the basis of biomass, density, and frequency following exposure to different levels of radiation. His studies report the influence of radiation on the first five years of old-field succession (Daniel, 1963). Species are oriented to the radiation gradient according to their tolerance to radiation and other environmental factors including light (Daniel, 1962), soil moisture, and competition. Elimination of radiation sensitive species presents an opening which is then occupied by species which are adapted to this altered microenvironment, usually at an earlier stage in succession. A hardy perennial may retain its position in the community by vegetative growth even though it is unable to complete its life cycle by producing viable seed.

Species of *Smilax* were found to be much more sensitive than most plants to radiation (Chappell, 1961, 1962, and 1963). A dose of 1,000 rads to lateral buds caused visible reduction in growth in the stems produced the following year. Underground buds apparently enabled these plants to survive high doses of radiation because of the attenuation of the radiation by the intervening soil.

An analysis of the effects of radiation on the soil (Cummins, 1962) and the microbial populations in the soil (Stanoviek, 1960 and Stanovick, Giddens, and McCreery, 1961) has further indicated the effects on other aspects of the communities surrounding the reactor.

Peromyscus leucopus (white-footed mice), *Peromyscus polionotus* (the beach mouse), and *Sigmodon hispidus* (cotton rat), were studied with respect to their survival to radiation exposures (Schnell, 1963). Habitat shielding of 77 to 88 per cent enabled some of the introduced populations to survive aerial doses which approximated 7 times the lethal dose-50. The behavioral patterns and pellage coloration were studied in recaptured mice.

McGinnis and Platt (1964) and Cotter and McGinnis (1965a and 1965b) described some of the aspects of recovery of the forest stands following release from the high radiation exposures in 1959 and 1960. Ecosystems began to recover immediately after the termination of the ecological stress of radiation. Generally the ecosystem was set back to an earlier stage from which the recovery began. Particularly important were those shielding factors that reduced the effective dosage. *Liriodendron tulipfera* (tulip popular), *Liquidambar styraciflua* (sweet gum), and *Cornus florida* (dogwood) were found to be particularly well adapted to recovery from sublethal radiation stress. It was found that the greater the radiation exposure the greater the amount of growth in the first year of recovery. The strength of the response decreased with increasing duration of recovery period until there were no significant differences in growth with respect to radiation in 1963, three years after the final major radiation stress.

Platt (1964) states that the ecosystems have regulatory mechanisms which parallel those of an organism in their homeostatic reaction to environmental stresses as drought, toxic chemicals, fire, violent wind storms, insect plagues, disease, and radiation. In considering the effects of radiation on ecosystems he emphasizes the importance of the duration of the radiation; the biological interactions, innate tolerances, and physiological conditions of the component species; the manner and timing of exposure, as well as possible attending conditions such as fire; and the availability of replacement species.

A summary of the effects of short-term radiation exposures to different temperate ecosystems is presented in Figure 1. The generalizations presented here hold true for the most part but there are many variables to be considered when applying this information to specific communities.

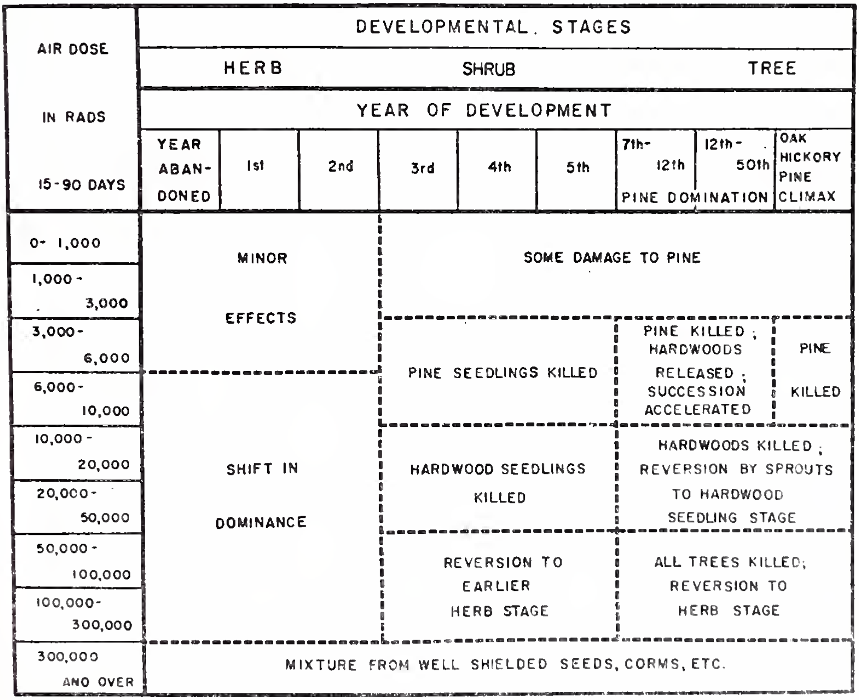
SUMMARY AND CONCLUSIONS

This paper reviews some of the work on the effects of radiation on biological systems. It is restricted to the effects of short-term radiation from point sources.

High-level radiation is an added environmental factor that places stresses on individuals, populations, communities, and ecosystems. Different portions of each of these have varying abilities to compensate for the effects of radiation; thus survival is dependent upon the reaction of the individual parts. For example, if the root systems are more radiation resistant or receive a sub-lethal exposure, recovery from radiation may be initiated by the growth of underground sprouts, even though the aerial portions were killed. Survival is a common index of radiation damage, but it involves two different concepts: sensitivity and resiliency. Survival is essentially governed by the sensitivity of the individual parts of the systems, but resiliency is much more complex and involves the whole remaining recuperative potential of the systems.

Following release from sub-lethal radiation stress, recovery will ensue, and here major differences in the responses of different systems may be seen. The degree of resiliency of a system may be affected by the amount of radiation induced damage, but it is influenced by other factors, either present before radiation occurred or altered by the radiation. Radiation is merely the accelerator that releases these recovery responses to a greater or lesser degree. This aspect of radiation ecology is just beginning to be analyzed.

The factors which affect recovery will vary with respect to the particular system being analyzed. On the organismal level it may be the available food supply for growth, the auxin metabolism, or some other factor only partially affected by sub-lethal exposure; on the population level it could be the genetic diversity, or the ability to respond to a changed micro-environment; on the community level it may be changes in the biotic relationships, and on the ecosystem level it may be the complexity of the system. Additional changes may occur in these systems as they recover from the effects of radiation and set in motion a whole spectrum of secondary responses.



AIR DOSE IN RADS 15-90 DAYS	DEVELOPMENTAL STAGES								
	HERB			SHRUB				TREE	
	YEAR OF DEVELOPMENT								
	YEAR ABANDONED	1st	2nd	3rd	4th	5th	7th-12th	12th-50th	OAK HICKORY PINE CLIMAX
							PINE DOMINATION		
0- 1,000	MINOR EFFECTS			SOME DAMAGE TO PINE					
1,000 - 3,000									
3,000 - 6,000				PINE SEEDLINGS KILLED			PINE KILLED ; HARDWOODS RELEASED ; SUCCESSION ACCELERATED		PINE KILLED
6,000 - 10,000	SHIFT IN DOMINANCE								
10,000 - 20,000				HARDWOOD SEEDLINGS KILLED			HARDWOODS KILLED ; REVERSION BY SPROUTS TO HARDWOOD SEEDLING STAGE		
20,000 - 50,000									
50,000 - 100,000				REVERSION TO EARLIER HERB STAGE			ALL TREES KILLED; REVERSION TO HERB STAGE		
100,000 - 300,000									
300,000 AND OVER	MIXTURE FROM WELL SHIELDED SEEDS, CORMS, ETC.								

FIGURE 1. A summary of the effects of short term radiation exposure on plant communities.

As more studies are completed, the understanding of the effects of radiation and the interaction of recovery responses will enable us to predict more accurately the responses of these systems to different radiation treatments.

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An Inventory Control Model For Alabama Wholesalers

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Alabama wholesale businessmen are faced with the dilemmas and frustrations of attempting to maintain stable sales, to provide customers with adequate services, and to keep inventory at a reasonable level.

Many Alabama wholesale business concerns have between twenty and fifty percent of their capital invested in inventory. Success or failure of the firm sometimes depends on the management of this investment. Inventories have often been referred to as the graveyard of Alabama business.

A recent study of 62 Alabama small wholesale business firms by the Small Business Administration revealed that two factors seem to cause inventory problems. These were failure to assign responsibility and allocate time for inventory record-keeping purposes, and failure to maintain a good inventory control system.

The report goes on to point out that "In nearly half of the 62 Alabama wholesale firms interviewed for the study, a top management officer with many other important duties was responsible for inventory control. Only four of the firms considered it a full-time job, and only two had a special inventory clerk. Five out of six relied on observation to check the amount of stock on hand" (2).

The object of this paper is to (1) point out the economic importance of inventory control to Alabama wholesalers, (2) discuss the factors inherent in approaching an inventory control procedure, and (3) enumerate some of the more acceptable scientific methods which Alabama wholesalers may use in controlling inventories.

ECONOMIC IMPORTANCE OF INVENTORY CONTROL

Effective inventory control is important because: (1) the wholesaler must meet the demand of the retailer, (2) inventory costs are a substantial part of wholesaling costs, (3) wholesaling concerns operate on narrow profit margins, and (4) inventory represents money.

Demands of Retailers

The significance of this factor may be shown by using a simple example. Suppose that inventory is composed of bulky expensive items such that only a few are normally kept on hand. Each time a sale is made an order is issued to the factory for the replacement of the item sold. In cases of this nature the practice is usually to keep only samples and take orders for future delivery. This forces the retailer to bear the burden of delay. In many markets, however, the retailer is not willing to make a purchase unless immediate delivery is guaranteed. Thus, no sales are made or the chances of a sale are diminished. The outcome is that the wholesaler must be able to meet retailer demands, and to do this inventories must not be allowed to fall below some minimum.

Inventory Costs and Narrow Profit Margins

Since inventory costs represent a substantial portion of operating costs, major emphasis must be placed on them. Inventory costs are composed of carrying costs and the costs of not having inventory. Carrying costs are composed of obsolescense, maintenance, depreciation, insurance, taxes, interest on invested capital, and storage costs. The costs of not having inventory are incremental; costs of rush orders; additional handling costs; and the cost of purchase, receipt, and inspection of goods.

The theory that some level of wholesale inventory will yield a maximum return on the amount invested is based on two costs: the cost of carrying inventory increases as inventory levels increase and the cost of not carrying inventory increases with decreasing inventory levels. An inventory economy is achieved when the unit cost of carrying inventory is equal to the unit cost of not carrying inventory.

Money

The value of inventory decreases as corrosion, accidents, and physical deteriation come into play. Insurance, storage, and other costs accumulate as the company pays for the privilege of ownership. A minor design change, a switch in customer preference, a dip in the market price, even a leak in the warehouse roof — these are but a sample of the deflationary forces which may cause a devaluation in the wholesaler's inventory.

HOW TO APPROACH INVENTORY CONTROL

One of the most important steps in efficient control of wholesale inventories is to approach the problem with a definite conception of the factors entering into the "how much and when" decision. An effective model for this decision can be built by answering the following three questions: (1) What is in stock? (2) Is it sufficient? (3) Is it too much?

What is in Stock?

The answer to this question requires either a periodic physical count or some system of data processing which issues a continuous flow of inventory information.

One of the more acceptable methods of maintaining a continuous flow of inventory information is the perpetual inventory record. This record, sometimes referred to as "balance of store" or "balance forward" method, gives a running count of each item of inventory by furnishing information as to the issuance of units of each item and the receipt of new units of each item. This type record can be expanded to show the quantity on order and the quantity reserved for future orders.

Is it Sufficient?

The answer to this question is based on the answer to the first question. Once the quantity and type of the inventory has been ascertained, a decision must be made as to whether the inventory on hand is sufficient or not. If it is sufficient to meet sales requirements, how long will it last? If it is not sufficient, consideration must be given to the possibility of a "stock out" which could have a serious effect on sales and ultimately on the life of the wholesale firm.

To determine the sufficiency of an inventory, the stock quantity must be compared with the minimum inventory allowable based on sales requirements. To ascertain the minimum quantity of any item of inventory that should be on hand, certain factors must be taken into consideration. These factors are past sales; time required to place, process, and receive an order; dependability of suppliers; order quantity and reorder quantity; and margin of safety.

Is it too Much?

Sales are not affected directly if a wholesaler has too much in inventory; however, excessive inventories have serious consequences on the cost of sales. Sales revenue has to cover higher costs resulting from such expenses as obsolescence, maintenance, depreciation, and so forth. Since the average annual cost of maintaining an inventory is approximately 25% of the value of the inventory, wholesalers would be wise to trim the "fat" from their inventories.

SCIENTIFIC INVENTORY CONTROL MODEL

Answers to the four questions discussed in the preceding section may provide Alabama wholesalers with a guide for a more scientific determination of the only two decisions which create inventory: (1) "how much" of an item to purchase, and (2) "when" to purchase items. These two decisions refer to reorder quantity and reorder point respectively.

Economic Order Quantity

Of major importance to Alabama wholesalers in approaching more scientific inventory control is a distribution-by-value analysis. This analysis reveals the relative annual dollar usage of the different types of inventories. It is not uncommon for some wholesalers to discover that 80% of the annual dollar usage in inventory is concentrated in 20% of the items.

Probably one of the most widely used inventory classification systems is General Electric's ABC system. This system classifies inventories into three categories. The following example (1) illustrates very adequately the ABC system.

General Electric ABC Inventory Classification System

Inventory Class	Degree of Economic Importance	Percent of Inventory Items	Percent of Annual Dollar Usage
A	Major	10	70
B	Intermediate	15	20
C	Minor	75	10

This type of distribution is significant because it provides a basis upon which the wholesaler can determine the amount of effort and money to be spent on the control of the various items in inventory. Of importance in inventory-value analysis for Alabama wholesalers is the price that will be used in determining inventory values. Accountants can provide the firm with FIFO, LIFO, and Standard Cost figures. The recommended accounting method of pricing inventory is the lower of cost or market price, applying the first in, first out principle.

The next step in studying wholesale inventory is the determination of working and safety stocks. Before continuing into an analysis of these two elements of inventory, the following definitions are deemed necessary:

1. Working Stock — that part of a wholesaler's inventory which takes care of normally anticipated sales and is created by retail orders.

2. Safety Stock — that part of the wholesaler's inventory which is maintained to insure against deficiencies in working stock.

3. Reorder Point — that point where an order is placed with the manufacturer to replenish working stock.

4. Average Working Inventory – one-half the quantity (working stock ordered).

5. Margin of Safety – that time interval between a wholesaler's reorder point and the receipt of the goods ordered.

Using these definitions, under ideal conditions no wholesale safety stock is necessary because the quantity ordered at the reorder point is received at exactly the time existing inventory is depleted. The reorder point and order quantity are determined by past sales and margin of safety. Past sales and margin of safety do not always behave in the same manner; therefore, some protective measure must be adopted to avoid an out-of-stock situation.

A "pad" or safety stock quantity must be created to reduce the possibility of a stock out. The Alabama wholesaler's economic order quantity decision can be determined with the aid of a simple mathematical formula. The generally accepted formula for the economic order quantity is:

$$Q = \sqrt{\frac{2AB}{I}}$$

Q = Economic order quantity in dollars
A = Annual sale in dollars
B = Cost of processing an order in dollars
I = Cost to carry inventory, as a decimal

The mathematical manipulations of the formula are illustrated in the following example.

TABLE I
Inventory Model of Four Products Ordered Quarterly

Product	Annual Sales	Annual Orders From Manufacturers	Size of Order	Average Inventory
A	$ 8,100.00	4	$2,025.00	$1,012.50
B	2,500.00	4	625.00	312.50
C	1,600.00	4	400.00	200.00
D	900.00	4	225.00	112.50
	$13,100.00	16	$3,275.00	$1,637.50

Looking at Table I, two costs can be inferred. It costs something for a wholesaler to process an order and to carry inventory. If some way can be found to reduce the number of times merchandise is ordered from the factory or reduce the inventory, better control of inventory costs will be achieved.

In a given wholesale inventory, the optimum relationship will exist between average working inventory and the total number of orders from a manufacturer when the individual order quantities are a constant function of the square root of individual sales. The corresponding formula (I) is as follows:

$$Q = K\sqrt{A}$$

Q = Order Quantity
A = Annual Sales in Dollars
K = A Constant

The difficulty with this formula is the determination of the constant (K). To find the constant (K) that will reduce a wholesaler's inventory in a given stock without increasing the number of orders from the manufacturer, divide the sum of the square roots of the annual sales by the present number of orders.

The corresponding formula (II) is as follows:

$$K = \frac{\Sigma\sqrt{A}}{\Sigma N}$$

N = Number of Orders

Applying this formula for determining (K) to the data in Table I, (K) is as follows:

$$K = \frac{210}{16}$$

$$K = 13.125$$

Applying this value of (K) to Formula (I), a new table may be constructed showing the reduction in inventory.

TABLE II
Initial Stock Order
16% Reduction in Inventory

Product	Annual Sales	Annual Orders From Manufacturers	Size of Orders	Average Inventory
A	$ 8,100.00	6.9	$1,181.25	$1,378.12
B	2,500.00	3.8	656.25	328.12
C	1,600.00	3.0	525.00	262.50
D	900.00	2.3	393.75	196.88
	$13,100.00	16.0	$2,756.25	$1,378.12

The calculations for order quantities (size of orders in Table II) are presented below:

Product A	**Product B**	**Product C**	**Product D**
$Q = K\sqrt{A}$	$Q = K\sqrt{A}$	$Q = K\sqrt{A}$	$Q = K\sqrt{A}$
$Q = 13.125\sqrt{8100}$	$Q = 13.125\sqrt{2500}$	$Q = 13.125\sqrt{7600}$	$Q = 13.125\sqrt{900}$
$Q = 13.125 \times 90$	$Q = 13.125 \times 50$	$Q = 13.125 \times 40$	$Q = 13.125 \times 30$
$Q = \$1,181.25$	$Q = \$656.25$	$Q = \$525.00$	$Q = \$393.75$

Now that a (K) has been determined which will reduce wholesale inventory without increasing the total number of orders from a manufacturer, how can a (K) be determined which will reduce the number of orders without increasing the original inventory?

To find the constant (K) that will reduce the number of orders in a given stock without increasing the average working wholesaler inventory, divide the sum of the order quantities by the sum of the square roots of the annual sales.

The corresponding formula (III) is:

$$K = \frac{\Sigma Q}{\Sigma \sqrt{A}}$$

Applying this formula for determining (K) to the data in Table I, (K) is:

$$K = \frac{3{,}275}{210}$$

$$K = 15.595$$

Applying this value of (K) to Formula (I), a new table may be constructed showing the reduction in the number of orders.

TABLE III
Initial Stock Order
16% Reduction in Orders Per Year

Product	Annual Sales	Annual Orders From Manufacturers	Size of Order	Average Inventory
A	$ 8,100.00	5.8	$1,403.55	$ 701.775
B	2,500.00	3.2	779.50	389.75
C	1,600.00	2.6	623.80	311.90
D	900.00	1.9	467.85	233.925
	$13,100.00	13.5	$3,274.70	$1,637.350

The calculations for order quantities (size of orders in Table III) are shown below:

Product A	Product B	Product C	Product D
$Q = K\sqrt{A}$	$Q = K\sqrt{A}$	$Q = K\sqrt{A}$	$Q = K\sqrt{A}$
$Q = 15.595\sqrt{8100}$	$Q = 15.595\sqrt{2500}$	$Q = 15.595\sqrt{1600}$	$Q = 15.595\sqrt{900}$
$Q = 15.595 \times 90$	$Q = 15.595 \times 50$	$Q = 15.595 \times 40$	$Q = 15.595 \times 30$
$Q = \$1{,}403.55$	$Q = \$779.50$	$Q = \$623.80$	$Q = \$467.85$

Minimizing Total Costs of Inventory

A (K) of 13.125 will reduce wholesale inventory without increasing orders from manufacturers and a (K) of 15.595 will reduce orders without increasing wholesale inventory. A (K) of 13.125 will reduce the inventory by \$259.23, or 16% and a (K) of 15.595 will reduce the orders by 2.5, or 16%.

Assume it costs 25% a year to carry inventory and \$7.50 to process an order. A (K) of 13.125 will reduce inventory by \$259.23 which will mean a savings of \$41.50 and a (K) of 15.595 will reduce the number of orders by 2.5 which will mean a savings of \$18.75. The choice between these two alternatives, of course, would be the inventory reduction with a savings of \$41.50.

If constants of 13.125 and 15.595 will decrease costs, maybe some value of (K) other than 13.125 and 15.595 will increase orders but reduce inventory, thus achieving an even greater cost reduction. The constant (K) which will assure the lowest total cost of wholesale inventory is that one which is the square root of the term, two times the order cost divided by the cost to carry inventory. The order is expressed in dollars per order, and the cost to carry inventory is expressed as a decimal.

The corresponding formula (IV) is:

$$K = \sqrt{\frac{2B}{I}}$$

B = Cost of a wholesale order in dollars
I = Cost to carry wholesale inventory as a decimal

Using the values of \$7.50 for B and \$.25 for I, (K) is calculated as follows:

$$K = \sqrt{\frac{2 \times 7.50}{.25}}$$

$$K = 7.75$$

Applying this value of (K) to Formula (I), a new table may be constructed showing the increase in orders from the manufacturer and the reduction in wholesale inventory, thus achieving optimum order and inventory costs.

TABLE IV
Initial Stock Order
Optimum Inventory and Order Cost

Product	Annual Sales	Annual Orders From Manufacturers	Size of Orders	Average Inventory
A	\$ 8,100.00	11.6	\$ 697.50	\$348.75
B	2,500.00	6.7	387.50	193.75
C	1,600.00	5.2	310.00	155.00
D	900.00	3.9	232.50	116.75
	\$13,100.00	27.4	\$1,627.50	\$814.25

The calculations for wholesaler's order quantities (size of orders in Table IV) are presented below:

Product A	Product B	Product C	Product D
$Q = K\sqrt{A}$	$Q = K\sqrt{A}$	$Q = K\sqrt{A}$	$Q = K\sqrt{A}$
$Q = 7.75\sqrt{8100}$	$Q = 7.75\sqrt{2500}$	$Q = 7.75\sqrt{1600}$	$Q = 7.75\sqrt{900}$
$Q = 7.75 \times 90$	$Q = 7.75 \times 50$	$Q = 7.75 \times 40$	$Q = 7.75 \times 30$
$Q = \$697.50$	$Q = \$387.50$	$Q = \$310.00$	$Q = \$232.50$

Table IV shows an increase in orders to 27.4 and a reduction in inventory to $814.25. The order costs and inventory costs are computed as follows:

Total Order Costs = 27.4 orders × $7.50 cost/order
Total Order Costs = $205
Total Inventory Costs = $814.25 (inventory) × 25% (cost to carry inventory)
Total Inventory Costs = $203.56

Reorder Point

"When" to order, as pointed out earlier, is also an important factor for a wholesaler in inventory control. The formula for determining this is:

Order Point = Monthly sales × margin of safety in months + safety stock.

Variations in sales and margin of safety create the need for safety stock. Safety stock provides a "buffer" against unexpected variances in margin of safety and/or sales.

As is implied by the formula, the reorder point is a function of anticipated sales and margin of safety. If the reorder point is established as the product of margin of safety and sales, no safety stock is necessary. Under these conditions goods may arrive "after need" just as often as ahead of need and a stock out will occur approximately every other order.

Safety stock is created by establishing a reorder point greater than the product of sales and margin of safety. The amount of safety stock is proportional to the increase in the reorder point. Increasing the reorder point provides protection against stock outs in excess of a 50-50 chance per order. The optimum wholesaler's reorder point is where the cost of carrying safety stock is equal to the cost of stock outs.

CONCLUSIONS

Alabama wholesale enterprises, maintaining any kind of inventory, should be cognizant of the economic importance of inventory. Business managers should strive to exercise effective control over inventory so that costs will be minimized, sales will be optimized, and retailer demands will be satisfied. Alabama wholesalers must approach inventory control in a systematic manner. Wholesalers must be aware of the factors which enter into inventory decisions.

Many scientific techniques are available which will aid in wholesale inventory decisions. The techniques discussed here do not require any major revisions in existing records of the firm and do not require computers. Through a systematic analysis of inventory and its requirements, Alabama wholesalers can either develop or select a method of controlling inventory which will assist the organic function in attaining the enterprise's objectives.

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ABSTRACTS

Biology

Fishes from Limestone Springs of the Valley and Ridge Province of Mobile Basin

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The Valley and Ridge Province begins in central Alabama and extends northeastward through several states into Pennsylvania. Tributaries of Mobile Basin streams drain most of the physiographic province south of the Tennessee-Georgia line. This region of northeastward trending ridges and valleys is noted for the abundance of large springs developed in the limestone rocks.

The relatively constant temperature (15-18°C) and the very clear, pure water make springs a unique habitat. A distinct association of fishes occurs in most of the fifty-eight springs sampled. Species belonging to three families (Cyprinidae, Percidae, Cottidae) are the most common. Three undescribed species of fishes were collected. New data on the distribution of the Southern black-nose dace (*Rhinichthys atratulus*) were obtained.

Effects of Biotic Factors on the Behavior of *Fomes annosus* (Fr.) Cke.

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Fomes annosus (Fr.) Cke., a soil-borne pathogen, causes a serious root-rot disease of coniferous trees in Europe and the United States. Little is known about the ecology of this fungus relative to the influence of biotic soil factors, particularly soil microorganisms. Such basic information may indicate whether the pathogen can become established saprophytically in forest stands, and suggest possible control measures.

A field-plot experiment representing various cultural practices was conducted at the International Paper Company's Southlands Experimental Forest, Bainbridge, Georgia. Six cultural treatments were: burned; burned and disked; burned, disked, seeded with lupine; burned, disked, seeded with oats; burned, disked, seeded with rye; and a natural forest stand. Organic debris and soil samples were collected from plots and processed in the laboratory. Fungal colonization of washed and screened organic particles was determined by standard isolation procedures. Sterilized and nonsterilized portions of soil from each plot were tested for fungistasis against laboratory-grown spores of *F. annosus* by a filter paper-disc procedure. Other portions of natural soil were mixed with acid-washed sand in glass columns on a modified Audus-type perfusion apparatus arranged in a series. The columns of soil were perfused with water, then aerated while incubating 14 days. After incubation the columns were perfused 10 times with sterile water. The extracts were concentrated, sterilized, and incorporated in malt agar to test effect on diameter growth of *F. annosus.* Soil remaining in the columns was processed by a standard serial dilution and plate-count technique to determine microbial populations. Representative isolates of microorganisms were tested for antibiosis against *F. annosus.*

Species of *Trichoderma* and *Penicillium* were predominant in debris particles from all plots. *F. annosus* was not observed on any particles. In the fungistasis test, there was little difference for individual plots in the percentage of *Fomes* spores germinated on sterilized soil and on the no-soil check; differences among plots also were small. Growth inhibition of *F. annosus* was observed on plates containing extracts from the burned and burned-disked-lupine plots, while stimulation was observed in presence of extracts from the burned-disked and natural plots. Microbial densities varied from plot to plot, the highest population being in the burned-disked-lupine plot and the lowest in the burned plot. A high percentage of fungal isolates from all plots was inhibitory to *F. annosus.* Few of the bacterial isolates exhibited inhibition.

The Blood Picture in a Leukemic Strain of Laboratory Mice

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A new inbred strain of laboratory mice has been developed by Dr. Paul C. Bailey of Birmingham-Southern College. One hundred per cent of these animals develop a reticulum cell sarcoma when they are approximately eight months old. The blood picture (total red and white cell counts and differential counts) has been studied periodically throughout the entire life span of a sample of 50 of these animals. The results will be presented, and this data will be correlated with the time of enlargement of the peripheral lymph nodes.

The sarcoma is localized in the peripheral lymph nodes during its earlier stages. These nodes were removed from 50 of the animals at approximately two months of age. The blood picture has been determined in these animals and will be presented.

Some Characteristics of a New Inbred Strain of Laboratory Mice

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The author has developed a new inbred strain of laboratory mice. These animals are now in the 30th generation of breeding brother to sister. The characteristics of the strain have been determined, and these will be given. Particular attention will be placed upon a leukemia which appears to be hereditary and which appears in all animals when they are approximately eight months old.

The Fate of Insoluble Grit in the Avian Alimentary Tract as Determined by X-Rays

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Stones and pebbles have been identified in the gizzards of grain consuming birds since earliest times. It has been presumed that these relatively insoluble materials acted as an aid for breaking down grain to facilitate digestion. During the period of 1850-1920, many German workers investigated the effects of gizzardectomy and the effects of presence or absence of insoluble grit upon digestion. Most of our present knowledge concerning insoluble grit in the nutrition and digestive physiology of birds emanates from these studies and from studies carried out in this country some 25 years ago. Little critical information is available concerning the intake and fate of grit, and its effects upon digestive secretions, digestion, and absorption. Grit is still commonly found in the gizzards of wild birds, but it is no longer fed to most domesticated birds.

A series of experiments utilizing 5 randomly selected caged birds for each treatment were conducted to determine the intake of insoluble grit under various conditions. At the beginning of each experiment, the birds were subjected to X-rays to determine the status of insoluble grit in the gizzard. Adult S. C. White Leghorn male and female birds were used to study the effects of all mash, crumble, pellet, and grain diets with and without soluble grit (oystershell or limestone chips). In some tests birds were offered grit free choice and in others a known quantity was forced fed. By means of a series of daily X-ray pictures and fecal collections, it was possible to determine the fate of the consumed grit.

Individual variation between birds in response to grit was great, some individuals consuming no grit while other became gluttons.

Some birds that had been given a specific quantity of grit immediately excreted all, while others retained all in the gizzard. Other individuals quickly pulverized the material and excreted the fine particles. In general, there was a correlation between grit retention and the type and particle size of the diet. Birds fed mash and crumbles retained grit longer, followed by pellet and grain-fed birds. Birds receiving limestone chips pulverized and/or excreted the grit quickest.

Previous Auburn studies have found that grit increases the size of the alimentary tract, and that the tract has a pH of 7.0 or below. The proventriculi and gizzards are the most acid. The bile, which was either slightly alkaline or acid partially neutralized the pH of secretions leaving the gizzard, but the small intestine remained acidic. Females tended to have a slightly more acid tract than did males fed the same diet. Crumble, pellet, and grain diets made the proventriculi and gizzards significantly more acid. Granite grit did not increase acidity, but marble chips and oystershell did. The value of grit in stimulating alimentary secretion and absorption is currently being studied.

Since many commercial chickens are maintained on shavings litter, a study was conducted to determine how such birds would react to feeding grit free choice. Most individuals examined consumed copious quantities of grit and the gizzards remained full. Some individuals, however, consumed only a few pieces of grit and in a few days the gizzards were completely emptied and remained so.

Fluorometric Analysis of Intestinal Serotonin before and after Blockade

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One hundred eighty-four albino rats of the Holtzman strain were pre-treated with intraperitoneal injections of the monoamine oxidase inhibitor Marplan**, followed by doses of the tranquilizer, Serpasil (reserpine). In addition, several series of experiments were performed using the blocking drugs atropine sulphate and dibenzylene. Following each sequence of drug injections, the duodenum of the animal was excised at timed intervals, and assayed for serotonin content. The quantitative assay, originally used by Udenfriend (1957) at Bethesda, was modified for our purpose and consists of homogenization, extraction with n-butanol, acidification and measurement of the resultant fluorescence with a Turner-110 Fluorometer. With steroids and biogenetic amines, the degree of fluorescence and amount of the hormone was linear if proper technical precautions are practiced. This assay was designed to complement and to confirm earlier experiments of Ottis, Ingle, and Kimbrough utilizing perfusion techniques.

A protocol was followed which matched that of the perfusion phase, up to the point of excising the duodenal sections. At this point a determination of intestinal serotonin content was conducted. Fluorometric measurement data showed that this biogenetic amine, serotonin, was influenced by the drug treatment to an increase in concentration up to a mean level of 54% greater than that recorded for concurrently run, untreated controls.

Fluorometric data from the Blocking Drug Experiment showed a slight, although significant decrease, in duodenal serotonin in the animals treated with atropine sulphate and dibenzylene. These data, though less marked, were coincident with earlier findings in our laboratory of decreased intestinal motility of duodenums from animals pre-treated with the serotonin blocking drugs. *N.I.H. Training Grant Research Fellow, 5FI-MH-21, 380-02. Present address: Dept. of Biology, Birmingham-Southern College. **Marplan (isocarboxazid), supplied through courtesy of Dr. Donald Clark of Roche Laboratories, Nutley, N.J.

Studies on Calorigenesis in the White Rat

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Further research on thermogenesis has involved the use of aldosterone, Compound-S, epinephrine, epinephrine plus MAOI, epinephrine plus cortisone, norepinephrine and lipase in adrenalectomized and thyroidectomized animals. One hundred and ninety-six animals were used in this phase of the study.

Results were as follows: Doses of aldosterone starting at 10 ug and going as high as 60 ug, gave the adrenalectomized animal no protection against cold-stress. Compound-S gave no protection. Epinephrine in doses as high as 80 ug gave no conclusive results. The addition of a monoamine oxidase inhibitor to the epinephrine series gave no significant results. The use of 15 ug of epinephrine plus 10 ug of cortisone decreased the positive result obtained by cortisone in a previous phase of this investigation. Norepinephrine in doses as high as 30 ug gave no protection against cold-stress.

Comparing control thyroidectomized with control adrenalectomized rats under cold-stress, the temperature of the former started to drop only after ten hours of stress whereas the temperatures of the latter group started to drop, significantly, after two hours of low temperature stress.

Aspergillus Crown Rot of Peanuts in Alabama

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Aspergillus crown rot of peanuts, caused by *Aspergillus niger* v. Tiegh., has become a serious pre- and post-emergence disease problem on peanuts in the Southeastern States. Damage from this disease necessitated replanting peanuts throughout southeastern Alabama in 1963 and 1964, with some fields showing as high as 90 per cent plant mortality. Although the disease develops on plants from germination to maturity, it is most serious in the seedling stage. Penetration apparently occurs through damaged seed coats and the fungus spreads from cotyledons to the stem. Infection of nearly mature plants results in a general wilt. Sometimes a mass of spores of *A. niger* is found in infected tissue.

The disease is favored by conditions of high soil moisture, low fertility, poor soil texture, and continuous cropping with peanuts. Under Alabama conditions commercially available varieties show no specific resistance to the disease. Control recommendations include: avoiding excessive seed injury, planting peanuts in rotation with corn, small grains or other grasses, and seed treatment. Organic mercurials, applied at recommended rates to seed peanuts, have proved ineffective in controlling the disease because *A. niger* is tolerant of mercury. However, organie sulfurs and nonmercurial chemicals when used in combination with mercurial compounds control Aspergillus crown rot as well as other seed- and soil-borne pathogens of peanuts.

Influence of Nitrogen on Aflatoxin Synthesis by *Aspergillus flavus* in an Artificial Medium

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When grown in pure or mixed culture, strains of *Aspergillus flavus* Link ex Fries have been shown to produce a toxic substance that may result in acute liver carcinomas in a variety of animals.

Very little is known about the factors influencing production of the toxin, named aflatoxin by British workers, or about the pathways by which it is synthesized.

Highest yields of aflatoxin were produced by *A. flavus* when the fungus was grown on a medium containing at least one organic nitrogen compound. Tyrosine, tryptophan, phenylalanine, glycine, glutamic acid, and aspartic acid increased aflatoxin production when included in the medium. Little or no aflatoxin was produced when the organic nitrogen compounds were omitted. Similarly potassium nitrate and ammonium nitrate, two of the inorganic nitrogen sources tested, increased aflatoxin synthesis. This effect was not noted unless an organic nitrogen compound was also present. Although the pathway of aflatoxin synthesis is not known, data from these investigations indicated the importance of organic nitrogen compounds.

The Effect of Magnesium on the Growth and Morphology of *Arthrobacter globiformis* in Simple Chemically-defined Media

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Arthrobacter globiformis ATCC 8010 produced pleomorphic rod-shaped organisms from a coccoid inoculum in all synthetic media tested. These pleomorphic rods completed the normal life cycle, *i.e.*, formed cocci, in media containing glucose as the source of carbon and ammonium phosphate as the nitrogen source when the final concentration of magnesium was 1×10^{-3} molar but did not do so when the magnesium content of the medium was reduced to 1×10^{-4} molar. The organism was able to complete its normal life cycle even in the presence of limited magnesium (1×10^{-4} molar) when either glycine or glutamic acid served as the sole source of nitrogen and carbon or when glutamic acid was the source of nitrogen and glucose was the carbon source.

Chemistry

Chemistry in a New Venture in Creative Learning

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The development of the chemistry program in Mobile College, a new four year institution of higher learning, with first classes in 1963, is traced from conception to second year operation. Physical facilities, — laboratories, library, and lecture demonstration, — curriculum, — courses and requirements,— and staffing, including senior staff and laboratory assistants are discussed. Features of the new venture include opportunities for independent study and research.

Structure and Fertilizer Value of Organic Nitrogen Compounds

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As part of a study of the fertilizer value of organic nitrogen compounds, a survey was made of the literature in an attempt to correlate molecular structure with availability of the nitrogen to plants. Several general relationships were observed.

Within a given type of molecule, any change of structure which complicates the molecule hinders nitrification and decreases its agronomic value. Most non-cyclic compounds containing -C=N- are toxic to plants, but cyclic compounds containing this group are sometimes excellent fertilizers. Some types of compounds containing an inherent urea group, -NHCONH-, are good fertilizers, but other types are not. Compounds containing the -N-N- and -N=N- linkages are usually poor fertilizers. Other properties being equal, increase in the carbon-to-nitrogen ratio decreases fertilizer value.

Polydispersity of Hyaluronic Acid in Synovial Fluid

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Hyaluronic acid, a mucopolysaccharide of connective tissues which is composed of equimolar quantities of D-glucuronic acid and 2-acetamido-2-deoxy-D-glucose, was prepared that contained less than 4% protein from bovine synovial fluid by the cetylpyridinium chloride precipitation method of Scott. These preparations were analyzed for sodium hyaluronate concentration by the Dische method and for protein concentration by the Folin-Lowry method.

The electrophoretic mobility of the single sharp symmetrical boundary formed in Tiseluis electrophoresis at pH 8.6 in 0.1μ veronal buffer was 9.1. A similar single boundary formed in the ultracentrifuge had a Svedberg sedimentation constant of 2.77. These observations demonstrated the homogeneity of the preparations and are consistent with published data for hyaluronic acid.

The cetylpyridinium hyaluronic acid complex was completely soluble in 0.2 M Na_2SO_4. The complex containing high molecular weight hyaluronic acid is less soluble in more dilute salt solutions than that containing low molecular weight hyaluronic acid. Progressive dilution of a solution of cetylpyridinium chloride-hyaluronic acid complex in 0.2 M Na_2SO_4 to lower salt concentrations resulted in the fractional precipitation of the complex according to molecular weight. Seven fractions were obtained by this procedure.

The refractive increment of hyaluronic acid was determined with a Brice-Phoenix Differential Refractometer. Molecular weight and radius of gyration were determined for each fraction by light scattering utilizing the Zimm method of double extrapolation to infinite dilution and to zero angle of scattering. An IBM 7040 computer was programmed to do the calculations and plot the results. Hyaluronic acid of highest molecular weight was present in the fraction that precipitated as the cetylpyridinium hyaluronate complex at highest salt concentration. Its average molecular weight was 12×10^6. Molecular weights were progressively lower in fractions obtained at correspondingly lower salt concentration. The fraction collected at the lowest salt concentration had an average molecular weight of 150,000.

Intrinsic viscosity of the hyaluronic acid in each fraction was calculated from the specific viscosities of serial dilutions prepared from each fraction and extrapolating to infinite dilution. A Cannon-Manning semi-micro capillary viscometer was used in these determinations.

Results of the molecular weight determinations were correlated with intrinsic viscosity by a plot of logarithm of intrinsic viscosity against the logarithm of the molecular weight. This gave a linear relationship described by the equation, $[\eta] = k\ (M.W.)^a$, where $a = 0.17$ and k is a constant, 276. This investigation was supported by Public Health Service grants AM 07888 and AM 03555 from the National Institute of Arthritis and Metabolic Diseases and Merck, Sharp and Dohme, West Point, Pennsylvania.

Evaluation of the Sargent Model XV Polarograph, Micro Range Extender, and I. R. Compensator. Applications to the Determination of Fe III in Solvent Extraction Procedures

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The Sargent Model XV Polarograph was evaluated with a dropping mercury electrode using the usual cations. As expected, these methods failed with iron. Using the method of James J. Lingane, a satisfactory method was developed with a range to approximately 10^{-4}M. Attempts will be made to extend this range with the Micro Range Extender. Also, the effect of dielectric constant on the method will be studied. Applications of the procedure to the determination of iron III in solvent extraction procedures will be studied. NSF-URP Grant #GE-6416, financial sponsor of this research; W. R. Mountcastle, Jr., Director.

Solubility Studies of the Fe(III)·Di-Sec.-Butyl Phenylphosphonate

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When a very acid solution of Fe(III) is extracted with a 5% w/v solution of di-sec.-butyl phenylphosphonate in kerosene, a Fe(III)·di-sec.-butyl phenylphosphonate complex is formed. The solubility of this complex has been studied at varying hydrogen, chlorine, and ferric ion concentrations. The concentration of the ferric ion in the aqueous layer has been determined spectrophotometrically.

The soluble Fe(III)·di-sec.-butyl phenylphosphonate complex is unstable in strongly acid solutions. A study has been made of the apparent hydrolysis of this complex. NSF-URP Grant #GE-6416, financial sponsor of this research; W. R. Mountcastle, Jr., Director.

Experimental Procedures in Polymer Chemistry

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All plastic technology is based on the fundamental concept that an increase in molecular weight and chain length of a polymer results in materials of increasing strength, hardness, high flow temperature and decreasing solubility. A series of experiments to demonstrate various types of polymers are discussed. *The effect of molecular weight and chain length on properties of materials of the same chemical structure, film forming properties of high polymers, the effect of a plasticizer on the properties of plastic materials, the manufacture of plastisols, polymerization of a liquid resin of a solid by the action of a catalyst, the preparation of a moulding compound and the preparation of a cold setting polyester resin.* The implications of these observations from an instructional standpoint are discussed.

Geology And Anthropology

The Preceramic Horizon of Certain Bluff Shelters in the Sand Mountain Region of the Tennessee Valley in Alabama

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Eight small bluff shelters were excavated during 1962, 1963, and 1964 in the Sand Mountain region of the Tennessee Valley in northeast Alabama by the University of Alabama under contract agreement with the Archaeological Research Association of Alabama, Inc. All of the sites were located in Marshall and DeKalb counties. The shelters, formed by small streams cutting down through the Pottsville Sandstone formation, were similar to numerous other natural overhangs in the region. The sites showed stratigraphic evidence of occupation beginning during the period of transition between the Paleo Indian stage and the Archaic stage, and possibly earlier, and continuing intermittently through the Mississippian and into the Historic period. The longest and most extensive use of the shelters by aboriginal peoples was prior to the advent of pottery.

The Transitional Paleo Indian stage was represented in the shelters by projectile points classified as Dalton, Big Sandy I, and, less frequently, Beaver Lake and Quad. The antiquity of these types has been previously demonstrated by carbon 14 at the Stanfield-Worley site. One site, the Asbury Rock House (Ms 201), contained evidence of a possibly earlier occupation. At the Asbury Rock House, classic fluted material was for the first time found associated with Dalton phase materials in an early context. Although clear stratigraphic separation of these Cumberland fragments from Dalton material was not found, this association indicates that the Cumberland point is at least as old as Dalton. Heretofore, antiquity had been inferred on typological and technological grounds.

The early part of the Archaic stage was well represented in the sites by a number of characteristic pre-Shell Mound projectile point types and uniface tools. These projectile points are typically small, with ground bases, and include such types as Kirk, Morrow Mountain, White Springs, and Crawford Creek.

The shelters produced little evidence of occupation later in the Archaic stage other than a few characteristic large, stemmed projectile point types, although only a few miles away extensive shell middens were developing along the Tennessee River.

Preliminary Consideration of Burials from the Liddell Site, Wilcox County, Alabama

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Excavation at the Liddell Site (1Wx1) Wilcox County, Alabama, as part of the Millers Ferry Lock and Dam Salvage Project of 1964 resulted in the discovery of 38 burials. These, along with four other burials excavated at the site by Tandy K. Bozeman in 1961, provide examples of late proto-historic burial customs along the upper Alabama River. The majority of these burials and the major component on the site are a decline Mississippian manifestation strongly resembling the Fort Walton of northwest Florida.

Certain characteristic traits of the burials examined may be noted at this time. Burial urns, with both single and multiple burials, were a common occurrence. Urns were uncovered either in an upright position with the burial inside or in an inverted position covering the burial. The vessels utilized for the burial containers do not represent a specific mortuary ware, but rather reused general utility vessels. Urn covers, where present, were also utility vessels or, as in one specific case, a large section from a broken vessel. The other types of burial were deep or shallow pits with the burial in anatomical order and bundle or fragmentary burials in shallow pits. In all cases grave goods, other than burial urns, were limited in number.

Cherokee Acculturation: A Folk-Urban Study in Historical Perspective

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An analysis was made of historical changes in Cherokee Indian culture for the purpose of testing the concepts of “folk” and “urban” as polar societal types as devised by Robert Redfield in his study of four contemporary Yucatecan communities. A special attempt was made to learn if the same changes in cultural characteristics as noted by Redfield would be found in a group experiencing increasing degrees of urban influence through time.

After reviewing the major changes in Cherokee culture between 1540 and 1932, it was concluded that essentially the same alteration of characteristics did occur as were observed in Redfield’s study. These changes were in the form of disorganization of society in general, a loss of economic self-sufficiency, a breakdown of personal and kin-based relationships, an increase of labor divisions, the replacement of traditional thinking with rationality, and more recognition of the individual through utility and wealth.

A Ceramic Sequence in Central Alabama as Seen to Date

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A continuing archeological survey was made of the Alabama-Coosa-Tallapoosa riverine area in the vicinity of Selma and Montgomery with a specific sampling area roughly defined along an axis measuring from a point east of Montgomery to the environs of Selma on the western terminus of this area.

A total of twelve ceramic levels were either recognized or newly defined within this region. Related Woodland complexes involve Dunlap, Tchefuncte and Cartersville-Deptford cultures. Middle to Late Woodland periods relate to Weeden Island or northern Alabama cultural horizons. Of considerable interest is the Bear Creek complex which seems to involve a transition from Late Woodland into Mississippian times.

Four of the ceramic levels date to proto-historic or Early Mississippian times, one of these relating to Moundville ceramic traditions. Most recently, two new ceramic types were found and are in the process of being defined. One of these was discovered in western Autauga County and may be a significant horizon in Early-Middle Woodland times. The other may date to terminal Late Woodland and is probably related to the Averett complex of western Georgia.

The Ouachita Influence on Mississippian Facies in Alabama

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The Mississippian System in the Central Interior of the United States is comprised mainly of limestone which accumulated on a stable foreland shelf. In the Illinois Basin sandstones and shales within the Mississippian limestone sequence are deltaic and prodeltaic clastics which were derived from the continental shield (Swann, 1964). Toward the east and south the shelf sequence of limestones grades into much thicker geosynclinal clastics along the Appalachian and Ouachita Mountains.

The Mauch Chunk Group in the Appalachians of Pennsylvania

and West Virginia is mainly red mudstones and sandstones which pinch out and grade to other types of sedimentary rocks toward the west and south. The distribution suggests a source area along the northeastern margin of the Appalachian Geosyncline.

The Pennington Formation in southwestern Virginia and eastern Kentucky is comprised mainly of gray and brown sandstones, shales, and conglomerates. Because the formation thins and becomes progressively finer grained toward the west, a tectonically active source east of the Appalachian Geosyncline in southern Virginia and North Carolina is suggested. Perhaps the Floyd Shale of northwest Georgia and easternmost Alabama was derived from the provenance which supplied the Pennington clastics.

In the Ouachita Mountains of Arkansas and Oklahoma the Stanley-Jackfork-Johns Valley is a very thick gray sandstone and shale succession which thins and grades northward to limestone. The sediment source was a tectonically active area along the southern margin of the Ouachita Geosyncline.

The Floyd-Parkwood sequence of gray shales and sandstones in north-central and western Alabama crops out in the Appalachian Mountains and underlies Pennsylvanian beds in the subsurface of the Black Warrior Basin. At the southwest ends of the typical northeast-southwest Appalachian outcrop belts the sequence is comprised of sandstone and shale. Toward the northeast along structural strike sandstone grades to shale; and, the shale sequence contains limestone beds, which are notably absent to the southwest. In the Black Warrior Basin shale and sandstone in the southwest part of the basin grade northeastward to limestone along a facies boundary that trends northwestward from Birmingham to northwestern Alabama.

The facies distribution of the Floyd-Parkwood clastics in Alabama indicates a southwestern source, perhaps in west-central Alabama and central Mississippi. The inferred position of the sediment source and the lithologic similarity of the Floyd-Parkwood to the Stanley-Jackfork-Johns Valley suggests that both sequences were derived from the same tectonically active source and that both sequences belong to the Ouachita Geosyncline. During Mississippian deposition the Ouachita Geosyncline extended eastward from Arkansas and included the present Black Warrior Basin and the southernmost Appalachians in its eastern up-plunge end. Subsequent to Early Pennsylvanian deposition Appalachian tectonism expanded southward and westward to deform the eastern extremity of the older Ouachita Geosyncline.

Sulfide Mineralization in the Cragford District, Clay and Randolph Counties, Alabama

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In the Cragford area of Clay and Randolph Counties, Alabama, sulfide mineralization has been recognized for over 100 years. In the early days, the sulfide deposits were worked for free gold which occurred in the oxidized and supergene-enriched portion of the sulfide veins. Most of the gold prospects were abandoned soon after the water table was penetrated because the abundance of arsenopyrite and other sulfide minerals made separation and recovery difficult. During the 1920's and early 1930's, the old gold workings were revitalized in an effort to locate sufficient quantities of arsenopyrite for the manufacture of arsenous oxide.

The sulfide veins are lenticular to irregular masses of quartz, greisen and pegmatite, which strike about N. 35° E., and dip 35° SE. The sulfides consist chiefly of arsenopyrite, some of which is gold bearing, with lesser quantities of galena, chalcopyrite, and pyrite. Mineralization occurs in the veins as masses and disseminated grains or crystals but is commonly localized between relatively pure quartz and the enclosing phyllite wall rock.

Structural Geology of the Blount Springs Inlier, Blount County, Alabama

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The Blount Springs inlier is the last breached segment of the southern portion of the Sequatchie Anitcline. Longitudinal faulting and folding have exposed a series of beds ranging in age from Silurian to Pennsylvanian.

The structure was produced by reverse axial plane folding and faulting of the asymmetrical Sequatchie Anticline, and is structurally continuous with the main portion of the anticline. Isolation from the main portion of the anticline is a result of undulation of the anticlinal flanks, and variations in throw along the faults. Fault displacement is greatest in the central portion of the inlier and diminishes along strike to the N.E. and S.W.

Structural activity in the area is best explained by thinskinned tectonics. Geographic location of the anticline may, however, call for some degree of basement involvement.

The Migrant-Work Society: Mobile Social Compatibility

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Investigations of the migrant phenomena have in the past been oriented solely to the deviancy of these groups from the middle class idealism of the United States. Closer investigations of this realm of social ecology reveals among the migrants significant patterns, configurations of social and cultural values. Sociogenesis of cooperation and psychological groupings are evidently derivatives of cultural compatibility among group members. Using Linton's "alternatives" we may see these groups attempting to reinstate satisfactory cultural cores as a reference, rather tenuous in nature. In this relationship there is tendency toward reduction of "variants." While society as a whole looses form and pattern, the fundamentalist religion attempts to reinforce older culture patterns.

Physics And Mathematics

Mathematics in Jesuit Seminaries

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The mathematics programs in Jesuit seminaries in the United States are designed for the purposes of degree requirements and preparation of teachers in Jesuit high schools and colleges. The beginning courses include calculus and are taught in the two year period devoted chiefly to the study of Latin, Greek and humanities. Concentration programs in mathematics do not form a part of the seminary curriculum but may be included in courses of study where a seminary is located at or near a college campus.

Phase Velocity and Damping of Torsional Waves in Rubber Tubes Filled with a Viscous Fluid

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The frequency equation for torsional waves in a tube of infinite length with a homogeneous, isotropic, visco-elastic wall, immersed in vacuo and filled with a viscous fluid was programmed for a digital computer. The program was applied to several special cases of thin- and thick-walled tubes for frequencies ranging from 0.33 to 33 c.p.s. and for fluid viscosities between 0.01 and 1 poise. For thin-walled tubes the results obtained for velocity and damping agreed with those given by a formula derived earlier for these tubes.

It appeared that an increase of the wall viscosity gives an increase of the phase velocity and of the damping, while an increase of the viscosity of the fluid makes the phase velocity decrease. Its effect on the damping is dependent on the frequency. For the higher frequencies the damping increases with an increase of the fluid viscosity, but for lower frequency it decreases. This work was supported by a PHS Research Career Development Award GM-K3-15,444 and a PHS Research Grant (H5379).

Study of Dynamic Interactions of the Solid State by the Mossbauer Effect

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The generalized definition of the Mössbauer effect describes it as a zero-phonon transition between two stationary states of a quantum mechanical system coupled to a quasi-continuum of states. In the nuclear case, the system is given by a nucleon in the nuclear field, the nucleus being surrounded by shell electrons and embedded in the crystalline lattice. Because of the strength of the nuclear forces, the nucleus acts as a unit in taking up the recoil momentum in the emission or absorption of a quantum of electromagnetic radiation. In the optical case, the system consists of an electron whose stationary states are determined by the configuration of next neighboring ions in the crystalline lattice. Since the electron-neighboring ion-lattice coupling is of the same order of magnitude, the primary element is the electron undergoing bound to bound state transitions upon absorption or emission of a quantum of electromagnetic radiation. Both the nuclear Mössbauer effect and its optical analog constitute powerful tools of high precision in studying the dynamic interactions of the solid state. Many experiments which previously required elaborate nuclear quadrupole resonance or optical Raman scattering set-ups, now can be performed easier and more precisely with the Mössbauer effect. In particular, the optical Mössbauer effect has been employed in determining the peaks in the distribution of density of phonon states in crystalline MgO. This information has been extracted from optical absorption spectrum of the one-phonon bands located to the higher wavenumber side next to the zero-phonon transitions at 27,650 cm^{-1} and 9,572 cm^{-1}. The experimental arrangement and the theoretical analysis is described in detail.

Problem Areas in Shaped Charge Design

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A brief review is given of the historical development of shaped charges in the United States, with emphasis on conical liners, which have received the major portion of investigative effort. A more detailed account is given of a cylindrical shaped charge designed by Hayes International Corporation and of the problem areas encountered during the study program. This shaped charge did not produce a jet, but did project sizable particles downrange at velocities in excess of 45,000 feet per second.

Spectrophotometry of Chloroplast Suspensions

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Normal efforts to measure the light absorption spectra of turbid suspensions, such as those of chloroplasts, lead to results influenced by two major sources of error: light scattering losses, and the so-called "sieve effect." Latimer and Eubanks (Arch. Biochem. Biophys. 98, 274 (1962) proposed a method for correcting both types of errors. The object of the investigation was to check this method, examining the applicability of these corrections on a different optical setup and beam geometry using a Beckman DB instead of a Bausch and Lomb 505. Initial results indicated that the method was faulty. However, checks revealed that this apparent failure of the method was introduced by the excessively wide band half-widths programed into the operation of the Beckman DB in this spectral range. Semi-quantitative checks of this factor accounted for the apparent failures of the method being tested and supported the validity of the correction factors.

Industry And Economics

Adjustments in Size of Milk Producers: a Markov Process Analysis

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The number of Grade A milk producers in Alabama has decreased about 40 per cent during the past decade and the annual volume of milk sales by producers has almost doubled. These

changes are important to the dairy industry and their effect upon market structure should be identified and evaluated.

Markov processes may be used in describing changes in size distribution of milk producers and in projecting producer numbers by size categories. This process has been used by researchers in studying income and wage distributions, business concentration, soil mobility, food purchases, as well as analysis of size changes of agricultural and nonagricultural business firms. The general operation of this model consists of studying the movement of firms among specific size categories during specific periods of time. An equilibrium size distribution of producers would be expected to result if the type of movements initially observed continued indefinitely. Regular stochastic matrices, as employed in this analysis, have the property that when raised in power all rows tend to converge to a unique vector which gives the equilibrium size distribution of milk producing firms.

Milk sales were recorded for 1958 and 1963 for individual milk producers selling to milk handlers located in Alabama. During the 1958-63 period, there was a strong tendency for producers to move from the particular sales categories in which they started. A large percentage of smaller than average producers left the dairy business, whereas most of those remaining increased production substantially. The probability of going out of business tended to decrease as producers increased in size. Producer numbers were projected for 1973 and equilibrium. A continued movement of producers from dairy production was projected for 1973 and equilibrium. Most of the remaining producers moved into the larger size category, with annual milk sales in excess of 800,000 pounds. Thus, if the observed tendencies in size distribution of producers continue, the structure of Alabama's Grade A milk industry will be a few hundred large herds producing most of the milk for handlers in the State.

Some Economic Impacts of Agricultural and Industrial Development in a Six-County Area of Alabama

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People in counties that have predominately rural and agriculturally based economies will face problems of development that are uniquely different from those that arise in an urban and industrially based economy. The key economic variables, employment, population, investment and income, that have been involved in growth are used as a basis for contrasting growth in an urban county with that in the nearby rural area. This is an economic base study and agriculture is a basic industry treated separately to emphasize its role in the development process.

In the decade 1950-60, agricultural employment declined by 70 per cent in the rural area and by 64 per cent in the urban county (Tuscaloosa) and was associated with a 49 per cent decline in farms in both areas. Loss of agricultural jobs was so great that service or market-related employment decreased coincident with increased employment in other basic industries of the rural areas which indicates a ratio of new basic jobs to new service jobs of not greater than 100:1. By contrast, the base-service ratio of new jobs in the urban county was 100:178. After substantial migration, underemployment in agriculture still existed as indicated by the percentage of farmers working off the farm more than 100 days in 1959 — 42 per cent of Tuscaloosa County farmers and 35 per cent of the farmers in the rural area.

Investment per new basic-industry worker has been increasing in the rural and the urban area. The level of investment per new job in the urban area has been about five times greater than that in the rural area, $11,337 to $2,282 (undeflated) during the period 1940 through 1962. During the same period, as investment per worker has tended to increase, the number of new jobs in basic industry has shown a tendency to increase in the low-investment rural area by an average rate of 188 jobs per year. The number of new jobs has declined in the high-investment urban area by an average rate of 130 jobs per year.

The new-job structure as related to investment and the extent of underemployment in farming suggest the hypothesis that decentralized growth in employment activity in the rural area will continue. Also, growth in the rural area may receive added stimulus in the service sector from secondary or multiplier effects that have been essentially zero in the past, but which will become positive as basic industry other than agriculture becomes the major determinent of population.

The Expected Economic and Social Impact of Interstate Highways in the Birmingham Area

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Highway impact research has become a crucial component in the process of determining the feasibility of new or improved highways and in the allocation of the tax burden. Research in this area has been primarily concerned with the effects or benefits of limited-access highways on land use, land values, and shopping habits. The multi-purpose study of the impact of interstate highways in the Birmingham area is designed to explain and predict the economic and social consequences of a major investment in an area to users and non-users of the highways. The study being conducted by the Department of Marketing at the University of Alabama is especially designed to trace the micro-geographical spatial impact of highways on land use, accessibility, business and service facilities, land values, social institutions, and spatial shopping patterns of ultimate consumers.

The benefits and costs resulting from new and improved highways may not affect people or business firms with the same intensity or in the same time periods, and the net benefits may be transferred from one person to another, one area to another, one business to another, or within the activities of persons, areas, or businesses. Specifically, the investment effects and the resulting benefits and costs can be described under three sub-headings: (1) Improved productivity and efficiency of transportation within a given economic structure. Productivity and efficiency are improved by the operating economies obtained by highway users, although economic substitution, redistribution of income, frictional and/or technological unemployment can result by, for instance, the substitution of truck transportation for rail transportation. (2) The efficiencies resulting from expansion, consolidation, relocation, or reorganization resulting from highway investment are other forms of change caused by highway investment. For instance, the comparative advantage of a firm may change as a result of a highway investment, or the economic utilities of a location may change. (3) The combination of (1) and (2) which may result in a greater range of choice for the individual or business firm who may be a highway user or non-user.

The Current Status of the Economic Education Movement in Alabama

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Economic Education in Alabama can contribute significantly to the growth and development of individual students and enhance the possibility of further growth and development of the state's economy.

Since 1961, The Alabama Committee on Economic Education which is affiliated with the Joint Council on Economic Education and the Southern States Work Conference has sought to improve and expand the teaching of economics in the public school systems.

The objectives of this committee included the following: (1) Organization of a permanent council on economic education; (2) Development of interest and support of school administrators, economists, and teachers in developing and conducting an effective program; (3) Development of a satisfactory high school course and the establishment of a model "pilot school" program; (4) Encouragement of economic education workshops at the college level for in-service teachers; and (5) Increased emphasis on economics in the pre-service training of teachers, especially business education and social science majors.

The Joint Council on Economic Education has designated Auburn University as a distribution point for economic education materials.

Eufaula High School offered a proposed course in economics on a "pilot" basis in 1963-64. Auburn University conducted an economic education workshop for teachers during the summer of 1964. The Alabama State Department of Education added economics to the state course of study in 1964.

Additional information about the program may be obtained by writing Dr. Andrew Weaver, Chairman, The Alabama Committee on Economic Education, Auburn University.

Charge Account Banking: With Special Reference to the Sixth Federal Reserve District

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The past 35 years have brought a revolution in the attitude of commercial bankers toward lending. Formerly, most bankers considered it their duty to help consumers keep out of debt rather than to make it easy for them to obtain bank credit. This changing attitude is evidenced by the numerous retail banking services that have been developed and promoted in recent years. One of the most controversial of these new services is charge account banking.

This paper is intended to trace the origin and development of charge account banking in the United States and particularly in the Sixth Federal Reserve District. Some conclusions based on the findings of the study are as follows:

1. There have been two major periods of growth (1953 and

1959) and two major periods of decline (1954-58 and 1961-62) of charge account banking in the United States. The maximum number of plans in operation at one time in the United States was approximately 130 in 1960. Many of these plans have been discontinued since that time due to their failure to produce a profit. Today, there is little interest being shown in the development of new charge account programs by commercial bankers.

2. For the most part, the development of charge account banking in the Sixth Federal Reserve District has paralled its development in the remainder of the country. More charge plans have been started in Florida than in any other state in the Sixth District. Nevertheless, bank charge plans located in Florida have been plagued by failure. Today, the most numerous and the most successful programs of this type in the Sixth District are located in Georgia. Only one new plan has been started in the Sixth District since 1960.

Social Sciences

The Western Boundary of the Comanche Indians with Special Reference to the Royce Map in the 18th Anunal Report of the Bureau of American Ethnology

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The Comanche first appear in history in the Southwest near Taos about 1700. Thereafter, moving eastward to the Great Plains, they established themselves in the area between the upper waters of the Colorado River and those of the Brazos in Texas by 1750. From here they range northward into Kansas and southward into northern Mexico.

Spanish maps and reports of the late eighteenth century locate the Comanche in this area of Texas. At the same time they locate in eastern New Mexico the Jicarilla and Mescalero Apache. Under the Republic of Texas, the Comanche are found in their historic homelands in northwest Texas. After the Mexican War, railroad surveys in the West were the basis for maps of the Southwest which also placed the Comanche in northwest Texas. After the Civil War, treaties proposed to the Comanche find them agreeing to a western boundary which places them entirely in western Texas, their homeland now by this date for more than one hundred years.

Consequently the map of J. H. Powell in the *7th Annual Report of the BAE* is erroneous in showing the Comanche before the European occupation of North America, in eastern New Mexico and

Texas, as is the map of Charles C. Royce in the *18th Annual Report of the BAE* entitled "Texas and Portions of Adjoining States," which shows the Comanche boundary along the Pecos River in New Mexico, and which the writer is convinced rests on Powell's linguistic map.

Some modern writers on the Comanche, notably Richardson, and Wallace and Hoebel, seem unaware of the revision of the Powell map in Paullin's *Atlas of Historical Geography of the United States,* 1933, which properly shows the Comanche in 1650 in northern Colorado, and at that date reveals the Jicarilla and Mescalero Apache occupying eastern New Mexico. Suggested here for investigation is a companion map which would show Comanche, Jicarilla and Mescalero boundaries in the nineteenth centrury.

The Execution of the Mexia Prisoners, Tampico, 1835

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In November 1835, Colonel José Antonio Mexía, who had been exiled from Mexico in 1833 after failing to overthrow the government of President Santa Anna, attempted once more to unseat the President. At the head of some 150 North Americans and Europeans he had recruited in New Orleans, Mexía attacked the Gulf Coast port of Tampico. Failing in his effort to take the city from the local garrison, Mexía sailed away to Texas, leaving to their fate 28 members of his expedition, who had either surrendered or been captured. From the moment that Santa Anna learned of their capture, the prisoners' fate was sealed, for he immediately ordered their execution. In complying with the order, the local military commander followed the routine prescribed by military law for the interrogation and sentencing of the accused. This procedure delayed but did not alter Santa Anna's original command — the local authorities, after a week's questioning of the prisoners, not unexpectedly, prescribed death before a firing squad.

All efforts to ransom or otherwise secure the release of the prisoners failed to move Santa Anna, who wished to use their deaths as examples to deter the migration to Texas of other foreigners, especially from the United States. Although 11 of its citizens were among the victims, the United States government, already condemned by Mexico for failing to halt the movement of armed bands of its citizens into Texas, chose not to protest the executions.

Kossuth's Liberation from Turkey in 1851

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More than 4000 Hungarians escaped to Turkey after the armistice at Vilagos in August, 1849. Louis Kossuth, the Governor-President of the Hungarian Republic, was the most important personality among them.

Almost at the same time two great powers, Russia and Austria, suspended diplomatic relations with the Porte, demanding the extradition of Kossuth and other refugees. England, France, and the United States opposed any such step. Finally the Sultan accepted the protection of France and England and refused the demand, but the humiliating internment of the Hungarians was maintained.

Secretary of State Clayton ordered the American minister at the Porte to intervene in January, 1850, declaring that the deepest interest was felt among the people of the United States in the fate of Kossuth and his compatriots.

President Taylor believed, that there was "no valid objection to the emigration of these persons to a country so distant" as the United States. American diplomats had visited the Porte very often, assuring the Turkish government that Washington would be gratified if the refugees would find a retreat under the American flag.

The March 3, 1851 resolution of Congress "for the relief of Kossuth and his associates" reflected the growing impatience of American public opinion. In September, 1851 the Turks yielded to foreign pressure, and let Kossuth and other Hungarians board the U.S. warship *Mississippi.*

Leaders and Non-Leaders: A Study of Role Change in Children's Groups Composed of all Leaders and all Non-Leaders

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Six groups of children were studied, three groups composed of all leaders and three groups composed of all non-leaders. Two groups were made up of five year old children selected from nursery schools. Four groups were made up of ten year old Girl Scouts selected from Girl Scout troops. Each group met for a minimum of six sessions, two hours of observed time per session. Observers recorded behavior in such categories as influencing, being influenced, status indications, help, praise, and hostility.

The hypotheses tested were: (1) the direction of change for all leader groups would be toward less influencing activity; (2) the direction of change for all non-leader groups would be toward more influencing activity; (3) the two kinds of groups would become more alike in frequency of influencing activity; (4) leader groups would structure themselves sooner than non-leader groups; and (5) hostility would be greater in leader groups.

Hypothesis 1 was confirmed by the data. Hypothesis 2 was neither confirmed nor rejected. There was some evidence to support hypotheses 3 and 4, but with a small number of group cases, chance could not be ruled out. There was no evidence for hypothesis 5. Homan's marketplace theory was used to develop the hypotheses. Insofar as the data provided a test of the market-place theory, it was neither supported nor rejected. Developmental trends observed in the experimental groups were comparable with developmental trends observed in earlier research.

Discipline in a Distinguished Old Alabama Church, 1865-1890

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Ruhama Baptist Church, in the eastern section of Birmingham, is one of the ten largest Baptist Churches in the state. It is also one of the oldest, as it was constituted in March, 1819.

Detailed minutes of the business and religious activities of Ruhama were available for the period 1865-1900. The purpose of this study was to illustrate the application of such manuals of decorum as those of Hiscox and Pendleton on the conduct of the church members during the era. A further objective was to contrast the conscientious and servere application of scriptural admonitions and accepted dictums of church decorum with the much more liberal interpretation of church discipline which evolved after the turn of the century.

The purpose of church discipline in those years was to uphold the "purity of the church, the good of the offender and the glory of God." Offenses which were disciplined might be private or public, personal or general. It is interesting to note that in the amicable settlement of a private controversy, the sequence outlined in Matthew 18:15-16 was scrupulously followed. The object of discipline was "to gain a brother." A member brought before the fellowship of the church who refused to listen to the counsel of the church was "regarded as a publican and a sinner."

Common disciplinary charges of immorality included not only sexual trangressions but also murder, lying, larceny and drunkenness. Immoral acts were classified as "a sudden fault" or "grossly immoral." The doctrine of I Corinthians 5:11, which provided for social ostracism, or "excommunication" of those charged with wrong doing was made the basis of the treatment of these offenders.

Medical Sciences

Parameters Affected by Amytal (Amobarbital Sodium) in Rana Pipiens Gastric Mucosa in Vitro

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It has been reported that amytal blocks the electron transport chain between DPNH and FAD in liver mitochondria. This drug also partially blocks oxidation of succinate by an FAD flavin enzyme.

When 4×10^{-3}M amytal sodium was added to the bathing solution of a gastric mucosa that was secreting acid, the average time for inhibition of acid secretion was nineteen minutes. This action was reversible by removing amytal from the submucosa.

The effects of amytal were as follows:

Parameter	Units	No. of Exps.	Control	15-25 min. after adding Amytal	25-35 min. after adding Amytal
Hydrogen ion	μEq/hr/cm^2	20	3.13	0.47*	0.17*
Cl^- (N→S)	μEq/hr/cm^2	9	8.0	6.6	5.4
Cl^- (S→N)	μEq/hr/cm^2	5	4.3	4.9	2.6
Short circuit current	μEq/hr/cm^2	20	3.5	1.45*	1.14*
Potential difference	mV	20	21.6	21.3	15.6*
Resistance	Ohms/cm^2	20	138	314*	410*

* t test significant at .01 level.

In the period fifteen to twenty five minutes after the addition of amytal to the bathing solution, the secretion of acid and short circuit current were reduced. This reduction was greater than the decrease in net chloride flux. There was no change in potential difference during the period fifteen to twenty five minutes after the addition of amytal, but there was a significant reduction in the next ten minute period.

This data suggests that amytal may inhibit the secretion of hydrogen ion before significantly affecting chloride secretion, thus producing dissociation of the hydrogen ion and the chloride ion secretory mechanisms of the frog gastric mucosa.

Therapeutic Effect of Cortisone in Magnesium-Deficient Rats

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The typical nervous symptoms of magnesium deficiency in rats, hyperirritability with occasional convulsions, were produced by feeding young rats a magnesium-deficient diet. In two experiments, 2.5 mg of cortisone acetate was injected daily into some of the rats, beginning at the time the animals were started on the deficient diet. In both experiments, the cortisone caused a delay of several days in the occurrence of convulsive episodes. The cortisone partially or completely eliminated the peripheral vasodilation which is also a symptom of magnesium deficiency in rats. A third experiment was performed in which treatment of magnesium-deficient rats with cortisone was delayed until after nervous symptoms had appeared. In these rats, the daily injection of cortisone caused a cessation of hyperirritability and convulsions, which did not recur until after the animals had remained on the deficient diet for an additional period of more than one week. Cortisone treatment apparently had little effect on the peripheral vasodilation when this condition was already present when treatment was begun.

Studies on the Persistence of Vaccinia Virus on Fabrics

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The spread of microorganisms, including viruses, by fabrics has long been recognized as a problem of great public health significance. In order to develop means for preventing or controlling dissemination of viruses by fabrics, certain basic information is needed to determine the survival and infectivity of the agents on various fabrics under simulated "in-use" conditions. Uniformly sized swatches of cotton fabric, including sheeting, terry cloth, and knit jersey, and wool blanket and wool gabardine materials were exposed to constant amount of vaccinia (IHD) virus by pipetting 0.4 ml of a cell culture preparation of the agent onto each swatch. Immediately following exposure, five swatches of each fabric were macerated in an Omnimix homogenizer and the eluent assayed for virus content in H.Ep-2 cells grown in vinyl plastic panels. These swatches were used as "time 0" controls. Cytopathogenicity (CPE) was observed microscopically after six days incubation at 37°C, and a "grading system" was developed based on the degree of CPE seen in individual virus-cell cultures. The remaining virus-contaminated swatches were placed in sterile, elevated-lid petri dishes in 35% or 78% relative humidity at 25°C. After two hours, then weekly or biweekly, five additional swatches of each fabric were tested for the presence and quantity of virus. The number of $CCID_{50}$/ml recovered from each swatch at "time 0" was essentially the same as that of the original stock virus used. The virus content of each fabric, with the exception of wool gabardine in 35% humidity, rapidly decreased to an undetectable level by two weeks following virus exposure. Large quantities of the virus remained on the gabardine for over eight weeks post-virus exposure. Vaccinia virus was prepared from mouse lung tissue and used in studies similar to those described above. Results obtained from these experiments were essentially identical with those in which cell culture virus preparations were used. Fabric swatches were also exposed to vaccinia virus by aerosol and assayed for virus as described above. The results were very similar to those obtained from the swatches exposed to virus by direct contact. Supported by USDA Contract 12-14-100-7189 (63)

A Description of the Development of the Facial Muscles in Man

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The morphogenesis of the facial muscles was studied in 52 human embryos or fetuses 4.25 to 142 mm crown-rump length. Graphic or wax reconstructions were made from serial sections at ten representative ages. Various stains or impregnations were used. The microscopic study was compared with gross observations of a dissected newborn.

The mesenchyme of the second branchial arch in earlier embryos (4.25 to 14 mm) becomes increasingly dense but is not subdivided into distinct muscle masses. Between 14 to 18 mm the digastric complex and stapedius muscle is recognizable. By 22.2 mm five muscle masses appear as thin superficial laminae and are located in the occipital, temporal, anterior cervical, mandibular and infraorbital regions. The digastric complex has become the posterior digastric and stylohyoid muscles and the diagastric tendon. The muscle masses divide into superficial and deep groups. At 26 mm the mandibular lamina has extended into the lower face and the cervical lamina has extended down the anterior neck. The deeper buccinator mass is present in the cheek region. Most of the facial muscles, superficial and deep, are identifiable at 37 mm but no muscle masses extend to the midline of the face. Between 58 and 80 mm all the facial muscles assume their definitive location.

A Possible Correlation Between Eccrine Sweat Chloride Values and Respiratory Disease in Naval Recruits

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Eccrine sweat chloride determinations were done on a group of 540 white naval recruits on their first day of training during the months of June and July. All were healthy at the beginning of the observation period. Their ages ranged from 17 to 18 years. The mean value for chloride was 16 meq/liter and the standard deviation was 12.8 Those recruits who had a value greater than the mean value plus two standard deviations had an admission rate for pneumonia and pneumonia-like diseases which was significantly higher than those with lower values. Using a median of 14 meq/liter, there was also a statistically significant difference.

The Nature of the Heart Dipole

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A controversy exists if the heart dipole is a voltage-, current- or charge dipole. However, a dipole is defined by its field and this is given as soon as the location of the dipole (point singularity) and its moment are known. How one prefers to calculate the moment from the charges, from the potential difference or from the current is immaterial.

For the heart dipole in principle each of these three methods can be used, but in practice this is impossible. The components of the moment of the heart dipole are calculated from three linear equations whose coefficients are determined by measurements on a model of the human body which contains a "dipole" with known momentum. When the approximations, which have to be used would be fully allowed, this method would give the same result as the three methods mentioned above. Concluding we may say that there is no reason to specify the heart dipole as a current, voltage- or charge dipole.

Preliminary Study of Modifications in the Cultural Environment Effecting Hemolysis in Blood Agar Plates by Streptococci

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Streptococci isolated in 1963-64 from normal and infected throats of students showed variable hemolysis on blood agar plates between their primary isolation and subsequent cultures. The three readily available modifications of the standard blood agar plate chosen to study their effect on hemolysis were incubation: (1) under 10% CO_2 tension, (2) incubation at 20-22C, and (3) adjustment of the medium to pH ±7.9. Four apparently beta and two alpha hemolytic cultures were selected for this study. Of the four beta hemolytic cultures studied only one consistently produced beta hemolysis; one rapidly changed from beta to alpha under standard conditions and was usually alpha under each of the modifications; and the other two beta hemolytic cultures became alpha prime. One alpha hemolytic culture consistently developed alpha colonies under standard conditions and 10% CO_2 tension, but occasionally became alpha prime when the medium was adjusted to pH ±7.9 and once when the temperature was 20C. The other alpha culture sometimes produced alpha and beta colonies on the same plate under standard conditions and at pH ±7.9; it was occasionally alpha prime when grown under 10% CO_2 tension and once when grown at 20-22C. The irregular patterns of hemolysis produced by five of the six cultures in the standard blood agar plate and in each of the three readily available modifications emphasize the difficulties often encountered in the clinical laboratory. From this preliminary study it appears that cultural environment may influence the hemolytic reaction of streptococci.

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The Development Of The Cotton Rat, *Sigmodon hispidus texianus*, Through The First Nine And One Half Days Of Gestation

I. Ovarian Stages and Ovulation

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INTRODUCTION

Meyer and Meyer (1944) published photographs of a freshly ovulated egg. This egg had been flushed from the reproductive tubes and was described only briefly in the legend for the figure. Otherwise there seems to be no published reports on these stages of the development of the egg in *Sigmodon*. The purpose of this paper is to describe the development of the egg of *Sigmodon* in the ovary until ovulation.

MATERIALS AND METHODS

In order to estimate the age of embryos as accurately as possible, pairs of rats were placed together for mating only after the females were known to be in estrus. Estrus was detected by the vaginal smear method using the pipette technique (Snell, 1941); vaginal smears were stained with a trichrome mixture. Successful copulation was verified by noting the presence of a vaginal plug. Copulation was actually observed in only two instances. Other pairs that copulated did so when allowed to remain together for some previously determined period, such as two, three, four, eight, or twelve hours. The age of embryos was calculated from the time of observed or estimated time of copulation. Copulation was assumed to have occurred in the middle of the period during which the animals had an opportunity to mate, and the age of embryos was estimated accordingly.

Females to be sacrificed were killed with ether or by pithing. The ovaries and gential tubes were fixed immediately in Bouin's solution for 12 to 24 hours. After fixation the tissues were washed in running tap water and transferred to a solution of lithium carbonate. Tissues were stained *in toto* in Harris' haematoxylin for 12 to 24 hours, treated with acidified 70 per cent alcohol, and finally neutralized in basic 85 per cent alcohol. Sections were made by the paraffin method in the usual manner, and were cut at intervals of 10 micra. Ova were not removed from the uterus, and sections of

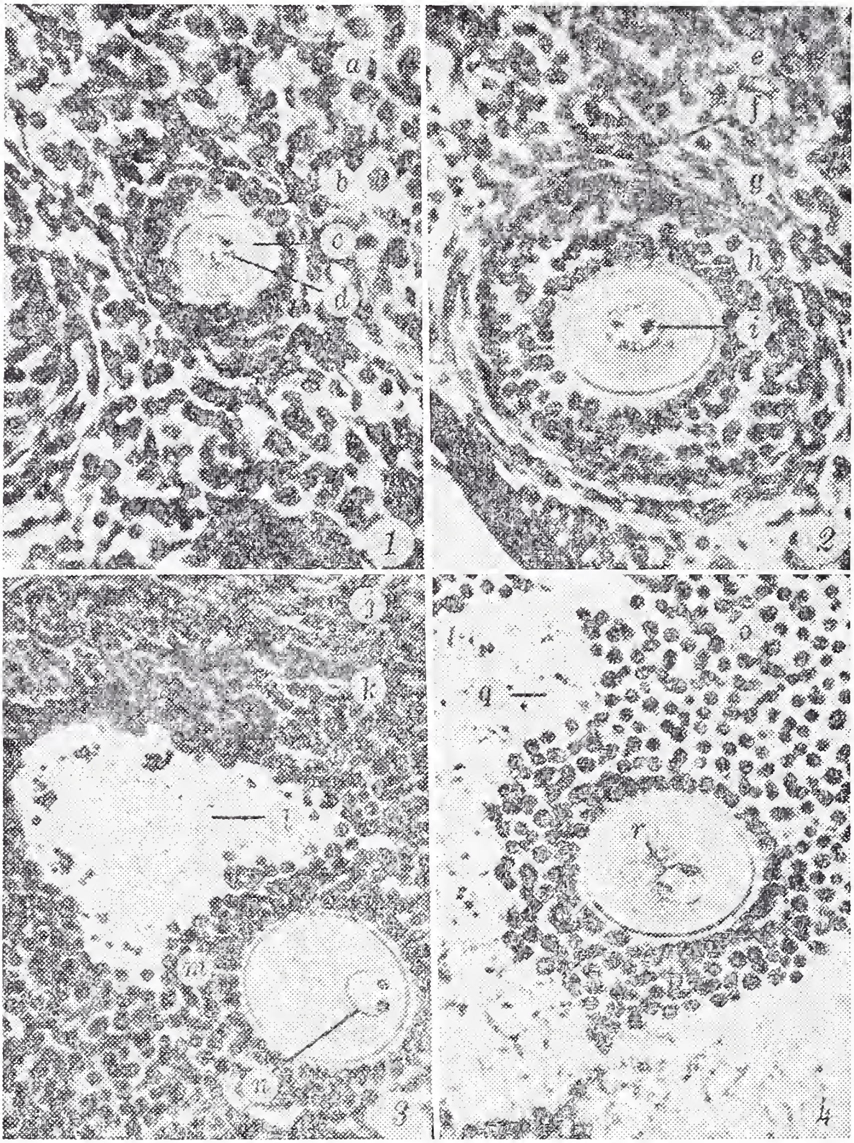


PLATE I

FIGURE 1. Primary follicle. a. Stroma of ovary. b. Cells of primary follicle. c. Primary oocyte. d. Nucleus.

FIGURE 2. Primary follicle. e. Stroma of ovary. f. Theca externa. g. Theca interna. h. Follicular cells. i. Nucleus.

FIGURE 3. Early secondary follicle. j. Theca folliculi. k. Follicular epithelium. l. Antrum. m. Zona pellucida. n. Nucleus.

FIGURE 4. Maturing secondary follicle. o. Stratum granulosum. q. Antrum. r. Nucleus of primary oocyte.

these were obtained by making longitudinal serial sections of the uteri containing them.

All measurements given were made of fixed or preserved material. Measurements do not include the pellucid membrane.

DESCRIPTION OF OVARIAN STAGES AND OVULATION

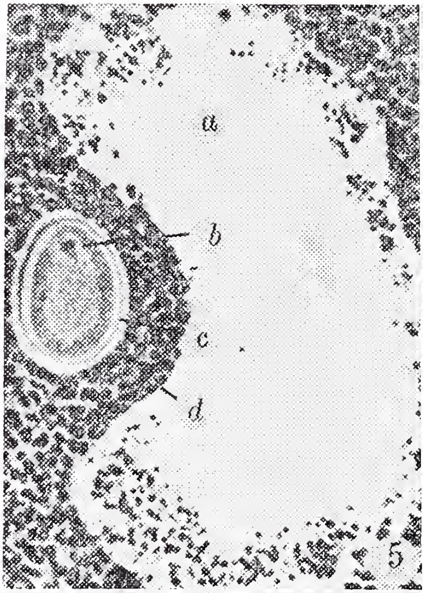
Ovarian ova: – The development of the ovarian egg of *Sigmodon* was similar to that in other mammals. Primary follicles (Figure 1, Plate I) were sparingly distributed in the cortex of the ovaries. A young primary follicle was approximately 68 micra in diameter and made up of a single layer of follicle cells enclosing a primary oocyte measuring approximately 40 micra in diameter. The nucleus of such an oocyte was clear except for scattered chromatin granules which stained lightly with Harris' haematoxylin. Primary follicles grew in size as follicle cells increased in number (Figure 2, Plate I).

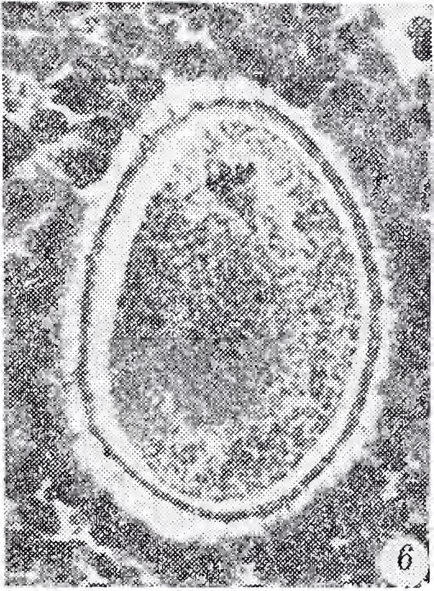
As follicular growth continued, vacuoles or spaces appeared among the follicle cells (Figure 3, Plate I). These spaces coalesced and formed an antrum, which marked the initiation of the secondary follicle. The follicle at this stage was approximately 280 micra in diameter. The oocyte approximated 54 micra in diameter and was eccentrically situated. Its nucleus was clear and chromatin granules stained lightly with Harris' haematoxylin.

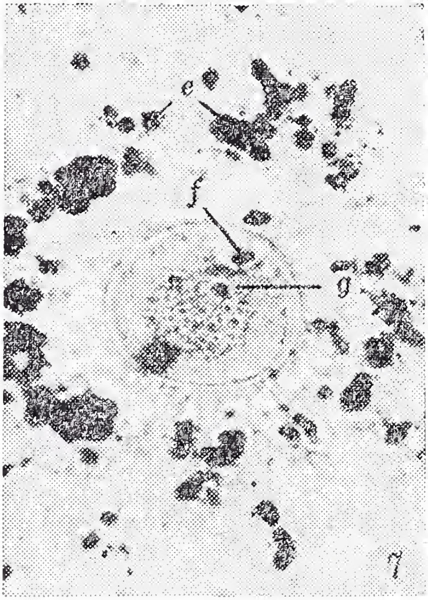
Mature ovarian follicles (Figure 4, Plate I) were found at the periphery of the ovary and approached 466 micra in diameter. They were distended by follicular liquid and bulged at the surface of the ovary. As ovulation approached, the superficial part of the follicle was raised into a local elevation, the stigma.

The oocyte was buried in a mass of follicular cells, the cumulus oophorus, and surrounded by a transparent membrane, the zona pellucida. Mature ovarian eggs measured approximately 82 micra along the main axis by 57 micra wide; the thickness of the zona pellucida was approximately five micra. The zona pellucida seemed to be weak and flexible before ovulation (Figure 3, Plate I; Figure 5, Plate II). As ovulation approached, cells of the cumulus oophorus which adhere to the oocyte constituted the corona radiata.

Ovulation: – Females sacrificed in estrus had some ova in the ovaries, whereas other ova were newly ovulated and situated in the upper ends of the oviducts. Ovarian ova clearly showed various stages of the first maturation division (Figures 5, 6, and 8, Plate II). Some ovarian eggs floated in the antral space in mature follicles. Some of these ova were undergoing the first maturation division (Figure 8, Plate II) while others had undergone the first maturation







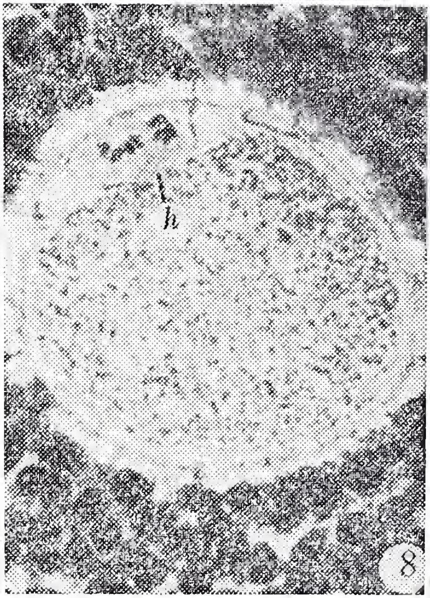


PLATE II

FIGURE 5. Mature secondary follicle. a. Antrum. b. Metaphase of the firs meiotic division. c. Zona pellucida. d. Cumulus oophorus.

FIGURE 6. Enlarged view of primary oocyte of figure 5.

FIGURE 7. The secondary oocyte prior to ovulation. e. Cells of the coron radiata. f. First polar body. g. Metaphase of the second meiotic division.

FIGURE 8. Enlarged view of the oocyte as the first meiotic division is occuring h. Late metaphase of the first meiotic division.

division and the nuclei were in the metaphase stage of the second maturation division. Floating ova were approximately 66 micra wide and 73 micra along the main axis. A perivitelline space appeared and the first polar body was situated in it (Figure 7, f, Plate II). Floating ova were further characterized by strands of adhering follicular cells, the corona radiata. Corona cells were large and vacuolized and their nuclei stained darkly with Harris' haematoxylin.

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Some Habitat Requirements Of *Triatoma sanguisuga* (Leconte) (Hemiptera: Reduviidae)[1]

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The Triatominae indigenous to eastern North America have received little attention from entomologists. In some other parts of the world these insects are well known because they parasitize man and transmit organisms that cause human diseases. Some species are well known because of their adaptability to living under laboratory conditions and their use as experimental animals in insect physiology. *Triatoma sanguisuga* (Leconte) is not commonly seen in nature and is not easily reared under ordinary laboratory conditions. Brumpt (1914) showed that this insect could be infected with *Trypanosoma cruzi* (Chagas), the etiological agent of Chagas' disease, and Davis, *et al.* (1943), found it naturally infected with the organism in Texas. Olsen, *et al.* (1964), indicated that this species was the naturally-infected vector of the disease among wild animals in Alabama. Since *T. cruzi* has been found in wild vectors and reservoirs in Alabama, an investigation was made of the habitats of *T. sanguisuga* to better understand the epizoology of the disease.

History and Distribution in Alabama

Early work by Marlatt (1896) indicated that *T. sanguisuga* feeds on bed bugs and was often found in bedrooms. Additionally, he reported that the adult was a night flyer and was attracted by light to open windows. Blatchley (1926) stated that the insect was known in the Southern States as the "big bed bug" and the blood-sucking cone-nose. He also reported that his specimens were collected from beneath loose bark of trees. The earliest records of this insect in Alabama are those from the Department of Zoology-Entomology, Auburn University. From about 1900 to 1943, records were made of insects sent to this Department for identification. During the indicated period there were only nine reports of this species; four indicated that the insects had bitten humans, another that the insect was collected from flowers, and the other four that no host was recorded. These collections were from Colbert, Etowah, Fayette, Jackson, Jefferson, Limestone, Randolph, and Talladega counties.

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[1] This investigation was supported, in part, by Public Health Research Grant AI-03307 from the Institute of Allergy and Infectious Diseases.

Members of this species were collected throughout the course of this investigation. In addition to the above counties, *T. sanguisuga* was collected in Baldwin, Barbour, Chambers, Lee, Macon, Lauderdale, Perry, Russell, Washington, and Winston counties. These counties are randomly distributed in the State and indicate that the species may be found wherever suitable habitats occur.

HABITATS OCCUPIED

Usinger (1944) pointed out a close association between Triatominae and woodrats and their nests. Early in our investigation, collecting was confined to woodrat nests. It was soon evident from the paucity and discontinuous distribution of woodrat nests in Alabama that *T. sanguisuga* must occupy other habitats. Analysis of early collection records showed that triatomids had commonly occurred in woodrat nests built in hollow trees or stumps and rarely in nests built in the open or around the base of solid trees. Therefore, hollow trees and stumps that did not contain woodrat nests were examined for the presence of Triatominae.

Many areas were searched during this investigation and a total of 60 collections was made. Thirty-seven of these collections were from hollow trees. Twenty-seven of the trees were oaks, but hollow sweet gum, elm, hickory, beech, and dead chestnut also served as habitats. Six collections were made from woodrat nests and five of these nests were located in hollow trees. Most of the triatomids collected in these habitats were nymphs, indicating that this habitat was favorable for reproduction of the species. However, large numbers of specimens were encountered only occasionally. Two hollow trees contained 17 *T. sanguisuga* and nine trees contained only one. An average of 5.4 triatomids was collected from infested hollow trees while an average of 4.9 was found in infested woodrat nests.

When *T. sanguisuga* was found in woodrat nests or in hollow trees, the insects were always remote from the nest chamber. They were usually located in cracks, crevices, and insect tunnels of the decayed wood. Presumably these locations provided protection from predatory action of animals occupying the den site or searching for food.

The only other generalized locale where *T. sanguisuga* was found was in and around human habitations. Seventeen collections were made in various habitats closely associated with humans. The insects were collected inside seven houses. Five of these collections were of adult bugs only. Two collections of nymphs indicated that the insects can reproduce in houses since the nymphs are wingless and cannot migrate long distances. In one instance, 9 nymphs were removed from a bed. Other collections were taken from within man-made structures including: an outdoor toilet, dog house, and corn crib, and from the outside of homes and other outbuildings. Other specimens were attracted to lights. All insects collected from these places were adults except the collection from a corn crib, which consisted of one adult and two nymphs.

Hosts and Food Habits

Usinger (1944) reported from his research and the literature that poultry, woodrats, and horses have served as hosts of *T. sanguisuga.* Blatchley (1926) reported on the symptomatology of bug bites on humans, and Marlatt (1896) reported that this species sucked human blood from engorged bedbugs.

Most species of the family Reduviidae are predaceous and feed on other insects. Only the subfamily Triatominae has the parasitic habit of sucking vertebrate blood. Our observations indicated that *T. sanguisuga's* food habits vary from true parasitism to intraspecific parasitism to predation.

The presence of triatomids in habitats that did not show signs of mammal occupancy stimulated a search for other hosts. When frogs and lizards with their mouths sutured shut were placed in cages with unfed nymphs, the triatomids readily fed on them. Amphibians and reptiles probably form an important alternate food source for triatomids since all three were often found cohabiting hollow trees.

Some of the smaller triatomid nymphs collected and examined in the field appeared to be engorged with a colorless fluid. Microscopic examination of the gut contents revealed cells that appeared to be insect hemocytes. Subsequent laboratory experiments showed that when unfed *T. sanguisuga* nymphs were caged with the larvae of Lepidoptera and wood-boring Coleoptera the triatomids would insert their mouth parts into the larvae and engorge themselves with hemolymph of the host insects.

Observations indicated that these insects will also parasitize their own kind (Hays, in press). Some of the bugs progressed from first to fourth instar stages of development utilizing as food only hemolymph from other *T. sanguisuga.* One insect was maintained in the laboratory for 556 days on such hemolymph only.

These observations revealed an interesting adaptation of *T. sanguisuga* to its habitat. While occupying a habitat that does not always provide a readily available meal of mammalian blood, the insect appeared to have several survival mechanisms in the absence of mammals: (1) it would feed on cold-blooded vertebrates in the habitat, (2) it would feed on other insects in the habitat, and (3) it would parasitize its own species.

SOME EFFECTS OF HABITAT HUMIDITY

Variations of humidity seemed to have little effect on well-fed nymphal and adult *T. sanguisuga* in the laboratory. However, humidity of the habitat markedly affected hatching of the eggs. Some eggs hatched at relative humidities of 44 to 100%; however, the greatest percentage of hatch occurred at 76-92% (Table 1). Eggs lost weight during early incubation at all humidities up to 97%. Greatest weight loss occurred in the lower range. In the range of 97 to 100% relative humidity, the eggs gained weight during early incubation. Fungi grew on the eggs at or near saturation and apparently killed the embryos. Results indicated that the eggs can tolerate a loss in weight during incubation of only 24-26% and still hatch. Relative humidity had little effect on the incubation period, but markedly affected weight of the resulting nymphs. Nymphs from eggs incubated at 44% relative humidity were approximately two-thirds as heavy as those from eggs incubated at 92% relative humidity.

A test was designed to determine the time during incubation when relative humidity was most important. Table 2 shows the combinations of relative humidities at differing periods of time. Results showed that high relative humidities were not as important in the early stage of incubation as in later stages when the humidities were within the tolerable but not necessarily the optimal range. The effect was even more evident when the eggs were moved out of the tolerable zone of humidity in later stages of development. Embryonic fluids appeared to evaporate as soon as the egg cracked and the young nymph was unable to emerge at low humidities. When eggs were placed at very low humidities early in incubation, the embryo appeared to dessicate beyond recovery.

Relative humidity was also important to survival of unfed, first instar nymphs. When unfed nymphs were subjected to environmental humidities below 65%, they lived only a maximum of 9 days, even though the eggs had been incubated at optimum relative humidities (Table 3). Death apparently resulted from dessication. As the humidity was increased, length of life also increased up to a maximum of 26 days.

SOME EFFECTS OF HABITAT TEMPERATURE

Late nymphal stages and adult *T. sanguisuga* were active and were collected in the field during all months of the year; therefore,

TABLE 1. Effects of various relative humidities on the weights and hatchability of *Triatoma sanguisuga* eggs. Weights in milligrams per egg.

No. eggs used	12	19	29	15	22	13	14	14	13	12	14
	Per cent relative humidity										
Date	0%	10%	22%	44%	55%	65%	76%	85%	92%	97%	100%
Beginning weight	.76	.82	.82	.82	.80	.83	.82	.81	.80	.77	.77
1st day weight	.39	.77	.81	.81	.79	.81	.81	.80	—	.78	—
2nd day weight	.39	.76	—	.80	.77	.80	.80	.79	.80	—	.78
3rd day weight	.39	—	—	.79	—	.79	.80	.79	.79	.79	.78
4th day weight	.38	—	.77	.78	.75	.79	.79	.78	.79	.78	—
5th day weight	—	.72	.76	—	.74	.79	.79	.78	.79	.78	.78
6th day weight	.38	.71	.75	—	.74	—	—	—	.79	.78	.78
7th day weight	.38	.69	.74	.75	.73	.78	.78	.78	.79	.77	.78
8th day weight	.38	.67	.73	.75	.72	.77	.78	.78	—	.76	.78
9th day weight	.37	.66	—	.74	—	.77	.78	.78	.78	—	.77
10th day weight	.37	—	.71	.72	—	.76	.77	.77	.78	.75	.70
11th day weight	—	.64	.69	.71	.68	.76	.77	.77	.78	.75	—
12th day weight	—	.62	.68	—	.68	—	—	—	.77	.74	.69
13th day weight	.35	.60	.67	.69	.68	—	—	—	.77	.74	.63
14th day weight	.36	.59	.66	.68	.67	.74	.76	.76	—	.74	.64
15th day weight	.36	.57	.65	.66	.66	.73	.76	.76	—	—	.66
16th day weight	.35	.55	—	.65	—	.72	.74	.75	.76	—	.66
17th day weight	.35	—	.61	.64	.64	.71	.74	.75	.76	.73	—
18th day weight	—	.51	.59	.62	.64	.71	.73	.74	.76	.73	—
19th day weight	.34	.49	.57	—	.63	—	—	—	.75	.73	.59
20th day weight	.34	.47	.56	.60	.62	.69	.72	.73	.75	.73	.55
21st day weight	.33	.46	—	.60	.60	.68	.71	.72	—	.73	.59
22nd day hatch or wt.	.33	—	—	1*	2*	1*	1*	3*	.73	—	.65
23rd day hatch or wt.	.33	—	.52	0*	13*	8*	9*	7*	4*	4*	3*
24th day hatch or wt.		.40	.51	0*	0*	3*	4*	4*	9*	4*	4*
25th day hatch or wt.		.38		0*	0*	0*	—	—		1*	0*
Ave. weight unfed nymphs in mg.	—	—	—	.420	.465	.526	.540	.569	.649	.626	.631
Per cent eggs hatching	0	0	0	6.6	68.2	92.3	100	100	100	75.0	50.0
Per cent wt. loss of eggs during incubation	58.0	55.3	39.2	26.7	24.6	17.7	12.3	10.1	8.6	5.1	21.7

* Number of eggs hatching.

apparently little affected by environmental temperature. Eggs and early instar nymphs were found only during the warmer months indicating that egg-laying ceased during the winter months. Eggs were collected from laboratory colonies and placed in rearing jars at 85% relative humidity and varying temperatures (Table 4). None of the eggs hatched at 10, 15, or 38°C. Hatching occurred in the range of 21 to 33° C with the optimum being about 26°C. Although fewer eggs hatched at either end of the range than at the optimum,

TABLE 2. Effects of varying humidity on the hatching of *Triatoma sanguisuga* eggs.

Test no.	No. eggs	First treatment R.H.	First treatment for No. Days	Second treatment R.H.	Second treatment for No. Days	Results
1	16	92%	1	44%	24	1 hatched
2	16	92%	3	44%	22	3 hatched; 2 others died in eclosion
3	14	92%	6	44%	18	2 hatched; 2 others died in eclosion
4	14	92%	17	44%	7	4 hatched; 6 others died in eclosion
5	9	92%	18	44%	5	9 hatched normally
6	15	92%	21	22%	3	2 hatched normally; 12 died in eclosion
7	13	44%	6	92%	18	10 hatched normally

TABLE 3. Longevity of unfed, first instar *T. sanguisuga* nymphs at various relative humidities.

Number of nymphs	Relative humidity	Length of life in days
13	97%	19-26
7	92%	12-20
14	85%	12-17
19	76%	8-19
10	65%	5-9
14	55%	5-8
10	44%	4-8

TABLE 4. Influence of temperature on the hatching of *T. sanguisuga* eggs held at 85% relative humidity.

Temperature in degrees C	Number of eggs	Incubation period in days	Percentage hatch
10°	5	----	0
15°	20	----	0
21°	19	39-44	72%
26°	24	22-24	100%
30°	13	17-19	93%
33°	20	16-18	75%
38°	15	----	0

the most marked effect was the difference in incubation time. Eggs kept at 21°C required 39-44 days to hatch, whereas those kept at 33°C hatched in 16-18 days.

SUMMARY

Triatoma sanguisuga occurs throughout Alabama living normally in hollow trees but also invading human habitations. It feeds upon mammalian, reptilian, and amphibian blood; the hemolymph of other insects, and also practices intraspecific parasitism. Optimum conditions for egg hatching are 16-92% relative humidity and a 26°C temperature. The greatest effect of habitat humidity is on the percentage of egg hatch, whereas the greatest effect of habitat temperature is on length of the incubation period.

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Possible Correlation Of Coal Beds On Sand And Lookout Mountains

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Alabama has long needed a comprehensive report on the Pennsylvanian coals of the state, along with some up-to-date coal reserve estimates. This finally came with Culbertson's report in 1964. Earlier, the same author had published a report (Culbertson, 1962) on coal bed correlations between Lookout Mountain, in Alabama, and Sand, Lookout and Raccoon Mountains in Georgia and Tennessee. The author of the present paper has written on parts of the three state correlation problem several times (Shotts, 1954, 1960a, 1960b).

The work of Culbertson on Lookout Mountain was based on his own observations and on previous work by Denson and Hose (unpublished, 1944), Denson (1947), and Coulter (1947), as well as on the much older reports of Hayes (1892, 1895, 1896, 1902), McCalley (1891), and Stevenson (1904).

Unfortunately, none of these reports, except the older ones of Hayes and McCalley, cover any part of the much greater area of Pennsylvanian rocks on Sand Mountain, from the Blount Mountain area, northeastward to the Tennessee and Georgia lines. This area of more than 500 square miles, lies in Marshall, Jackson and DeKalb counties. The older reports are not only out of date but carry little detailed information that is useful in stratagraphic correlations. Stevenson (1904) makes some interesting Appalachian-wide correlations but they are too sweeping and general to be of much help in specific correlations between Lookout and Sand Mountain.

Since 1953, the writer has driven through this area and has had opportunity to examine parts of it in some detail, especially in 1964, while working on a mineral resource project for the U.S. Bureau of Mines. From study of the reports of Culbertson (1964) and of Coulter (1947) and from observations on Sand Mountain, it appears that the coal-bearing strata in these once contiguious areas, have similar lithologies and apparently may be correlated.

Fig. 1 shows a graphic long prepared from Coulter's descriptive log of diamond drill hole FP-1 in the NW corner of the SE ¼ of SE ¼, Sec. 18, T7S, R10E, DeKalb county, Alabama. The other log is a composite one. From the position of the Fabius coal bed downward, it is the section found along Alabama Highway 117 in Norwood Cove, E ¼ Sec. 26 and NW ¼ of the Sec. 25, T2S, R8E, Jackson County, Alabama. From the Fabius bed upward, the section is

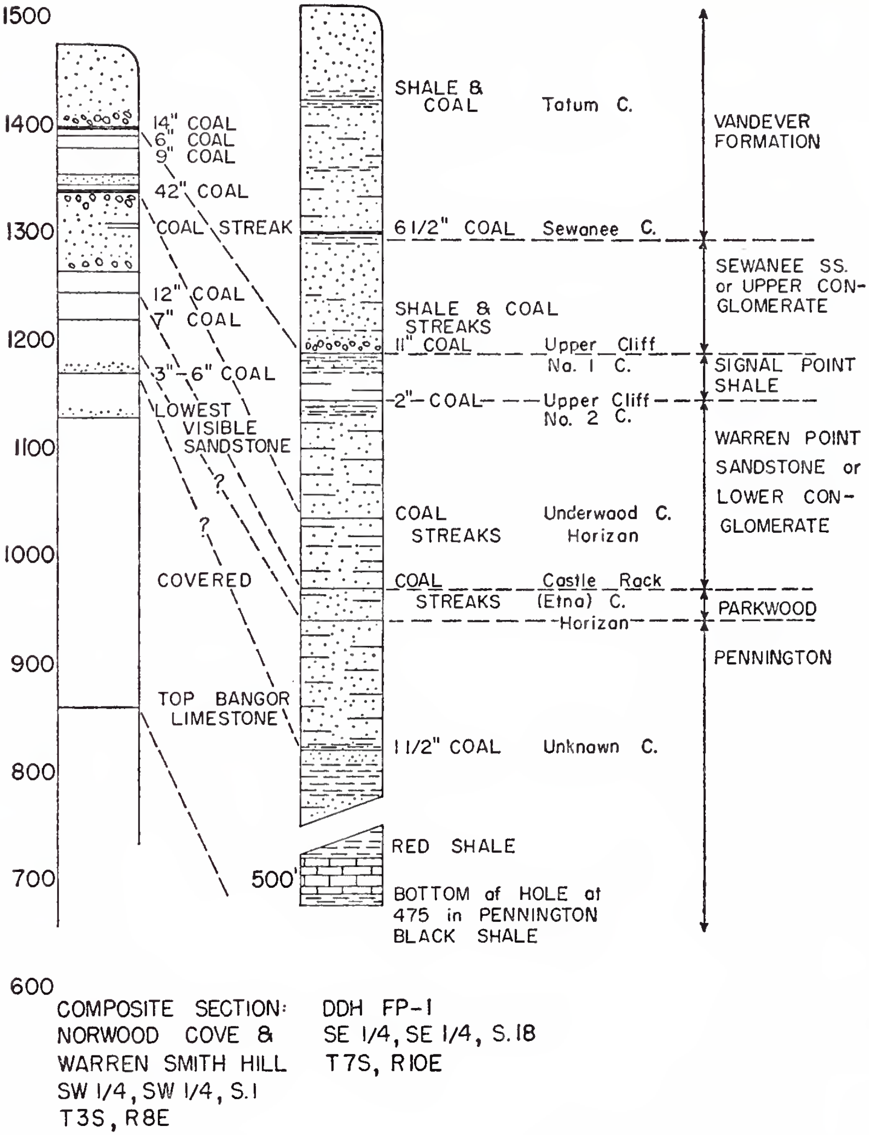

FIGURE 1. Comparative sections on Sand and Lookout Mountains with unit names used by Culbertson for Lookout Mountain.

found on Warren Smith Hill, Old Caperton Ferry Road, SW ¼ of SW ¼, Sec. 1, T3S, R8E, slightly over two miles due south of Norwood Cove. These two localities were chosen because Norwood Cove appears to show the best development to be found in the area of the lower strata, and Warren Smith Hill shows a maximum development of the coal-bearing parts of the section. On Warren Smith Hill, the Upper Conglomerate is a true conglomerate, while at Norwood Cove it is only a coarse, massive sandstone.

Topographically, the base of the Upper Conglomerate is 140 feet higher at Norwood Cove than at Warren Smith Hill so that elevations measured at the former section were reduced by that amount for Fig. 1.

The formation and member names used in Fig. 1 are the Tennessee nomenclature (Wilson, et al, 1956) and were correlated by Culbertson (1962) with the section of Denson and Hose (1944) on Sand Mountain and thus with DDH FP-1.

It is evident that Culbertson (1962) correlates the cliff facing Lookout Valley in both Georgia and Alabama, with both the Lower Conglomerate of McCalley (1891) and with the Warren Point sandstone of Tennessee (Wilson et al, 1956). More recently, however, R. L. Wilson (personal communication, 1964), using a type section made on the south side of Scratch Ankle Hollow, Marion County, Tennessee and Dade County, Georgia and within 3 miles of Jackson County, Alabama, identified the Upper Conglomerate as the Warren Point sandstone. He assigned the entire section of Dade County, Georgia, except possibly around Scratch Ankle Hollow, and probably the entire section of Jackson County, Alabama, to the Raccoon Mountain (Lower Gizzard group) formation of the Tennessee section (Wilson et al, 1956.) Fig. 2 shows his section for Scratch Ankle Hollow and his nomenclature is attached. If he is correct in assuming that the Lower Conglomerate of Georgia and Alabama is the equivalent of one of the Raccoon Mountain sandstones greatly expanded and thickened southward in Alabama and Georgia, then new nomenclature may be needed, if the Alabama and Georgia rocks are to be sub-divided.

In this paper, however, as shown in Fig. 1, the coal mined near Fabius, Alabama, is identified as the probable equivalent of the Underwood bed of Lookout Mountain which, according to Culberson (1962) is the equivalent of the No. 4 or No. 5 bed (Johnson, 1946) on Lookout Mountain in Georgia. Its position above or near the top of the Warren Point-sandstone would also make it equivalent to the Lower Wilder bed of Tennessee. The Upper Cliff coals would correspond to the Upper Wilder or Angel coal of Tennessee. If, however, R. L. Wilson is correct and the Warren Point sandstone is the Upper Conglomerate rather than the Lower, the Upper Cliff coals are in the approximate position of the Bon Air (Nelson, Etna, Battle Creek, Orme) coals of Tennessee and the Fabius coal may be the Lower Bon Air (Dade, Rattlesnake). The coals

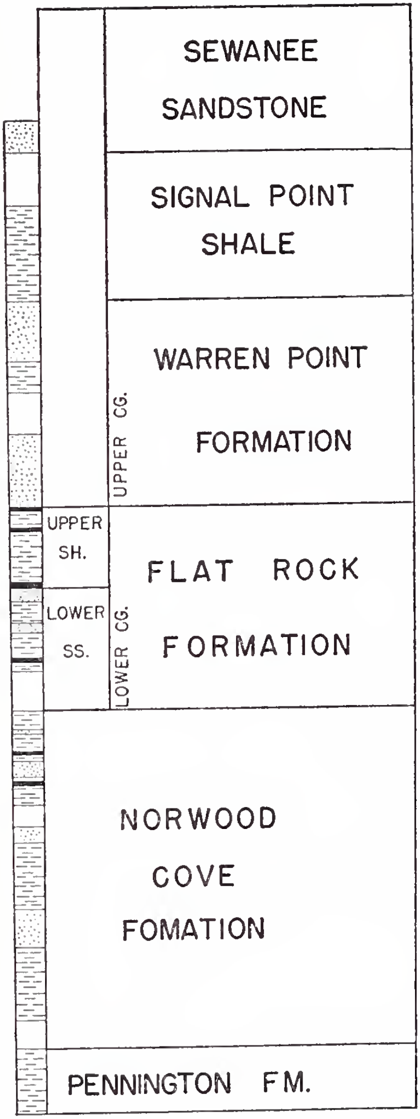

FIGURE 2. Suggested nomenclature and correlations of R. L. Wilson for Sand Mountain in Tennessee, Georgia and Alabama.

below the bluff in Norwood Cove would then correspond to the Sale Creek (Red Ash and Mill Creek) coals of Tennessee.

Culbertson (1964) quoted a description of the rocks on Lookout Mountain which was furnished him by Denson and Hose. My observations on Sand Mountain indicated that the greater part of the description would also fit the most common occurrences of the corresponding stratigraphic units on Sand Mountain. Among the features mentioned were:

1. "The rocks above the upper conglomerate consist of fine- to medium-grained, thin-bedded sandstones with much interbedded sandy, black and greenish gray shale." Although these rocks are rather thin in the Stevenson, Flat Rock and Henegar quadrangles on Sand Mountain, the descriptions are virtually identical except that dark and greenish-gray shales seem scarce on Sand Mountain.

2. "The most readily identifiable unit is the conglomerate and conglomeratic sandstone (upper conglomerate)." The same statement is true with regard to Sand Mountain. Indeed, above the horizon of the lower conglomerate is about the only consistently recognizable unit.

3. "It (the upper conglomerate) is characteristically a sugary, coarse grained sandstone containing numberous, well rounded milky-white quartz pebbles averaging ¼ inch in diameter." On Sand Mountain almost no pebbles larger than ¼ inch were seen. In many

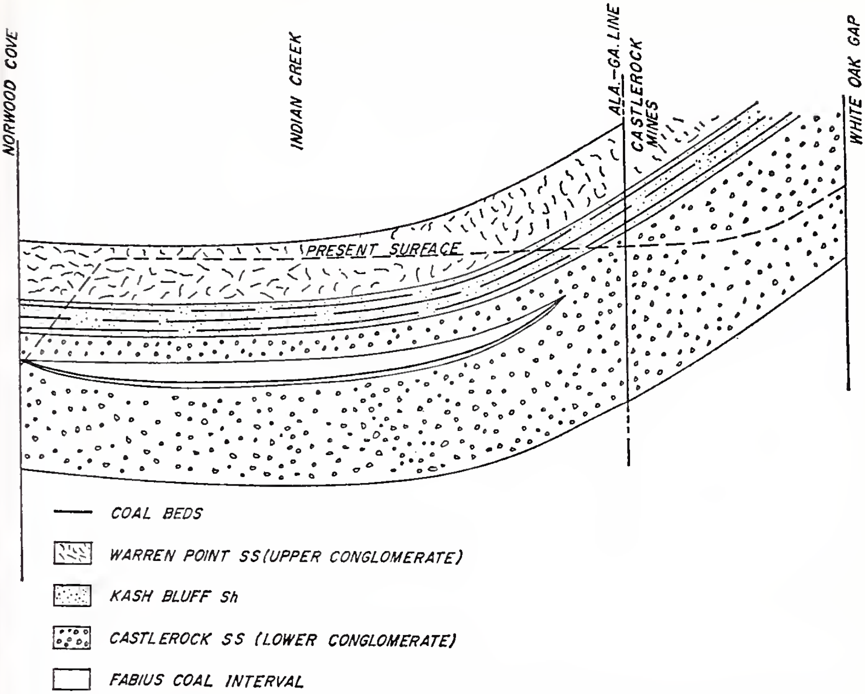

FIGURE 3. Possible stratigraphic relations of the coal-bearing units on Sand Mountain, Fabius-Flat Rock Area.

places, notably above Norwood Cove, the upper conglomerate is only a massive, coarse grained sandstone.

4. "In most places a zone 6 inches to 10 feet thick at or near the base of the (upper) conglomerate contains numerous angular shale inclusions. This zone normally weathers to a conspicuous vesicular rock that is very useful in locating the approximate geographic position of the underlying Upper Cliff No. 1 coal bed." On Sand Mountain the shale pebbles and vesicular weathered rock, are conspicuous above almost all the coal zones. A very beautiful example can be seen about 100 yards east of the Fabius post office on the Caperton Ferry Road. It lies above the Fabius or Underwood coal. Thin zones of this type can be seen near the base of the lower conglomerate in Norwood Cove, over the Upper Cliff No. 2 coal bed on Alabama Highway 71 near Floral Crest in the NW 1/4 of the Trenton quadrangle and in many other places. At the former Georgia-Alabama Ore Company strip mine about two miles southeast of Sylvania, vesicular conglomerate was very common above the coal bed. Insufficient work was done here to determine the exact stratigraphic position of this coal.

5. "Sandstone units as much as 130 feet thick separated by shale units ranging from 10 to 50 feet thick comprise the main part of the formation between the upper and lower conglomerates." On Sand Mountain the sands are much thinner and make a much smaller proportion of the strata in the Stevenson, Flat Rock and upper parts of the Henegar and Ider quadrangles but eastward and southward toward Lookout Mountain in the Trenton, Sulfur Springs, lower Ider and Sylvania quadrangles, this description appears to fit much better.

6. "The lower conglomerate – is similar lithologically to the upper conglomerate, but is not as persistent." This statement is generally true for Sand Mountain. At Norwood Cove, however the lower conglomerate is much more conspicious and persistent as a conglomerate than is the Upper. This is true in but few other places. Generally, the pebbles appear to be larger in the lower conglomerate of Sand Mountain than in the Upper but in many places they are sparse and scattered.

7. "Between the Mississippian Pennington Formation and the lower conglomerate is a unit of variable thickness – consisting of greenish-gray, regularly bedded shales and thin, fine-grained sandstone." Where seen on Sand Mountain, this unit fits the above description. An excellent example is found in Norwood Cove where a greenish-gray shale unit, highly fossiliferous, occurs about 20-30 feet below lower conglomerate and above one or two thin coal beds. Drill hole FP-1 (Fig. 1), the Norwood Cove occurrence and a thin coal bed just above reddish and greenish, obviously Pennington, shales in Smith Gap (S5, T6S, R9E, Dugout Valley quadrangle), has convinced this writer that Alabama, too, has Mississippian-age coal beds.

The obvious similarity in range of depositional conditions for all stratigraphic units in both Lookout and Sand Mountains render long distance correlations difficult and uncertain. The correspondences noted here offer a strong case for the correlation of the coal bed being mined near Fabius, Ala. with the Underwood of Lookout Mountain and the thin beds under the upper conglomerate, with the Upper Cliff beds. Fig. 3 shows schematically the writer's concept of the stratigraphic relations of the beds across Sand Mountain from Norwood Cove eastward to White Oak Gap near Trenton, Georgia. If this concept is correct, the Underwood bed seems not to be present on Sand Mountain very far east of Flat Rock, Alabama but the Upper Cliff beds seem to occur as far east as they are not removed by erosion.

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Surinam Geological Notes[1]

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INTRODUCTION

Surinam, a land of cultural and ethnological contrasts and intriguing geological problems, is attempting to explore and exploit her untapped mineral wealth for economic growth. The country was granted complete autonomy in 1954 by order of a constitutional charter from the Kingdom of the Netherlands. Until 1954, Surinam was largely unexplored and the geology imperfectly known or understood. The dense tropical rain forest cover hindered exploration and mineral exploitation. Gold and diamonds have been discovered by a few hardy prospectors and adventurers and these minerals have been produced intermittently (Fig. 1). The remote recesses of the "bush" prevented rapid communications and posed difficult and costly transport problems. The jungle still remains as a barrier to full exploitation and development. However, in 1960 the government sponsored "Operation Grasshopper" and constructed seven airstrips throughout the interior as an aid to ease this problem.

The Surinam government organized, along with other research departments, the Geological and Mining Service (Surinam Geologisch Mynbouwkundige Dienst), referred to as GMD, in recognition of the need for economic growth and improvement. Later, in technical and service support of the GMD, the Petrographic, Ore Study, and Mineralogical Institute (Petrografisch Ertskundig Mineralogist Institute), referred to as the PEMI, was organized. These organizations serve as research facilities under the Department of Development and their function is to geologically map the country, explore and evaluate potential mineral deposits.

The GMD is currently engaged in a 5-year geologic mapping program. The first phase of this program is the preparation of provisional geological/geomorphological maps on a one to 200,000 scale, employing photogeologic methods. The country has been divided into eighty alphabetized rectangular grids, measuring about 80 by 100 kilometers. The photogeology interpretations are field checked by crews traversing the country along rivers in corialls (dugout canoes, Fig. 2) and by foot along machete-cut jungle trails. The crews generally consist of a geologic aide and seven or eight men who survey the area by brunton-pace methods. Usually

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[1] Publication authorized by the State Geologist.

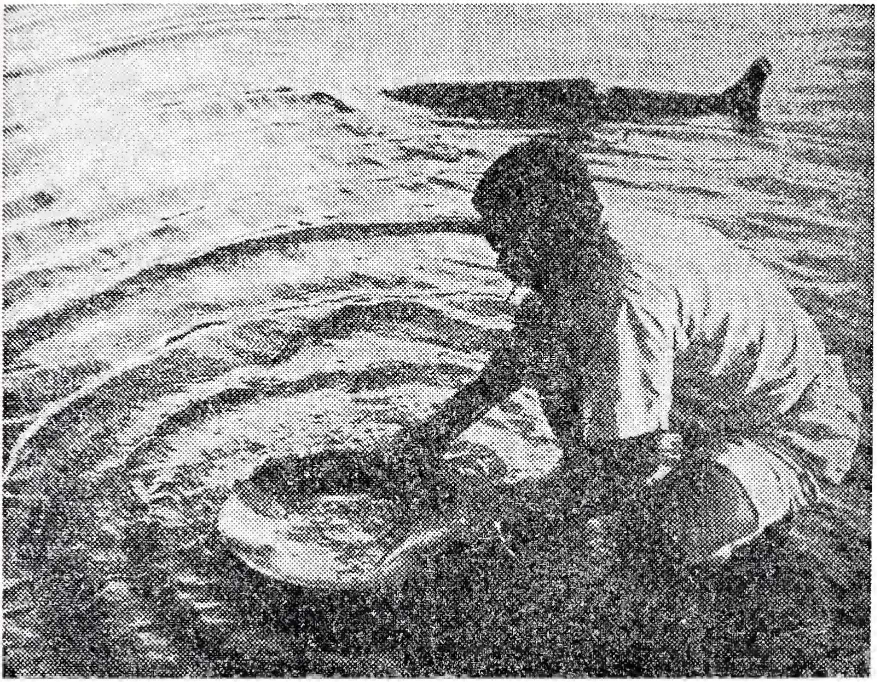

FIGURE 1. Prospector in the Surinam "bush" panning for gold with a batea.

a professional geologist supervises two such crews. To date, about 20 sheets, or about 25 percent of the country has been covered in this manner.

GEOGRAPHY

Surinam is on the northeastern coast of South America. The country is bordered on the west by British Guiana, on the east by French Guiana, and on the south by Brazil (Fig. 3).

The eapitol city is Paramaribo with a population of about 115,000. Overall there are about 300,000 inhabitants which consist of Creoles, Hindustanis, Indonesians, Amerindians, Chinese, Africans, and Europeans.

The country is divided into eight districts — Paramaribo, Nickerie, Coronie, Saramacca, Surinam, Commewijne, Marowijne, and Brokopondo.

Approximately 80 percent of the country's economy is based on the mining and exploration of bauxite. Timber, shrimp, and agriculture constitute most of the remainder. Some balata and gold are produced, but these are local and comprise less than one percent of the economy.

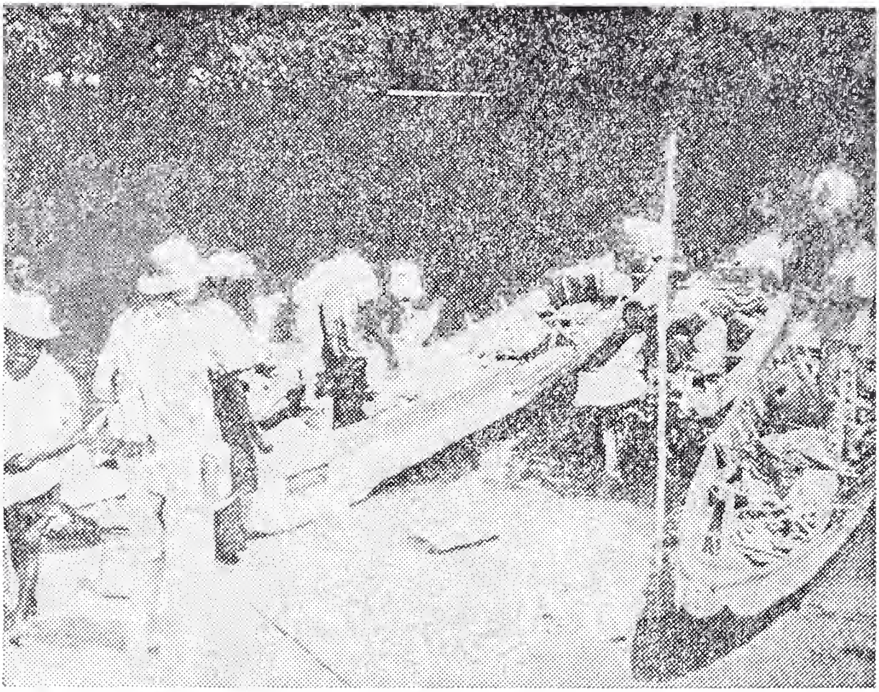

FIGURE 2. Loading supplies into 40 foot corialls (dugout canoes) for a prospecting trip into the bush.

PHYSIOGRAPHY

The northern part of the country is a young coastal plain of low relief underlain by unconsolidated marine and fluvial sediments (Fig. 4). Southward, toward the interior, the terrain becomes hilly and is well dissected by streams. Most of the dissected foothills are underlain by metamorphosed rocks which are predominantly mica schists and phyllites. Some sandstones and quartzites form the ridges. Regions of savannahs pervade the hilly terrain. To the south and southwest, deeper into the interior, the terrain becomes submountainous; occasionally mountain ranges with peaks up to 3,500 feet above mean sea level rise above the jungle floor. Most of the mountainous areas are underlain by granites, dolerites, and granodiorites.

The country has a well developed drainage system, which is to be expected in an area of rain forest cover. The major rivers are, from east to west – the Marowijne-Lawa-Tapanahony, the Surinam, the Saramacca (Fig. 5), the Coppename, the Nickerie, and the Corantijne-Lucie-Coeroeni-Nieuwe. All flow northward from the Brazilian border drainage divide and empty into the Atlantic Ocean.

During the rainy season the rivers become swollen and carry tons of debris and sediments into the coastal areas.

MINING

Two major companies are mining the bauxite deposits in Surinam. The Suralco (Alcoa) and Biliton (Dutch) have discovered extensive deposits of bauxite near Paranam and Moengo in the coastal plain in northeast Surinam. These companies have large mining concessions and mining permits in those areas. The production of bauxite represents about 80 percent of the country's economy. A large gold dredging firm is operating in the southeast on the Lawa River along the French Guiana border. Small gold prospects are operated sporadically in the interior, but the consumption is domestic.

The GMD and PEMI have discovered and studied deposits of beryl, mica, iron ore, diamonds, cinnabar, cobalt, nickel, manganese, columbite, tantalite, kyanite, platinum, chormite, tin, and lithium. Present studies are directed toward determining if the minerals occur in economic quanities.

Mining, finance, and tax laws have been passed and are extremely liberal and beneficial to investors or companies desiring to develop mineral deposits in Surinam.

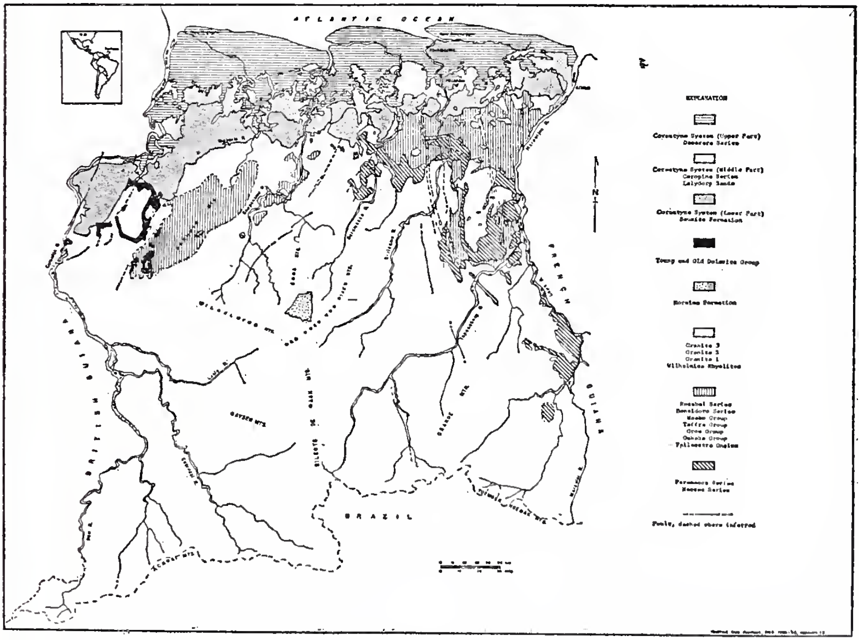

FIGURE 3. Generalized geologic and index map of Surinam.

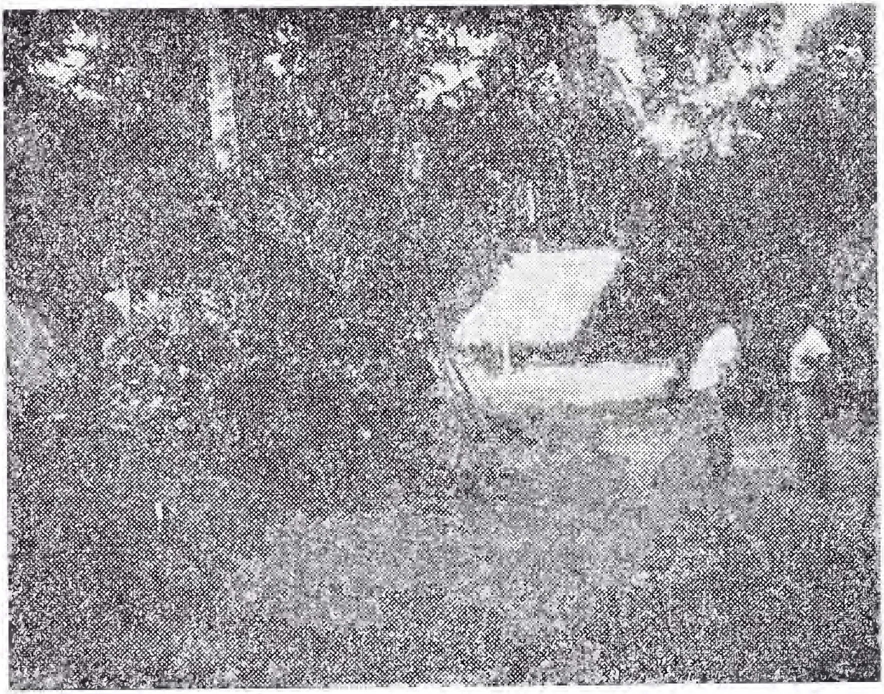

FIGURE 4. Djuka Indian village in the coastal plain area underlain by alluvial sands.

GENERAL GEOLOGY

Geologic work in Surinam is arduous and greatly hampered by the dense tropical cover (Fig. 6). Rock weathering is deep and rock exposures are rare except in the higher mountain ranges (Fig. 7). Fresh rock generally can be found on the crests of ridges that are underlain by quartz and quartzites, scattered along the banks and beds of major streams (Fig. 8). The "A" soil zone is leached completely of all but the most siliceous material and represents a thin veneer one to three inches thick. The "B" and "C" zones are extensive and deep, perhaps penetrating to depths of 300 feet in places.

Rock Units

In that large parts of Surinam have been mapped geologically only by reconnaissance methods, age relationships and the nature of rock types are imperfectly known or understood. However, continuing geologic work is adding new knowledge and the maps are being revised accordingly. The most recent stratigraphic column is presented in the following table and a generalized geologic map is shown in Figure 3.

Rock correlation in Surinam has been difficult and conflicting opinions exist. The lithologic and structural similarities of rock types with the bordering Guianas have been of some help.

Geologic units in Surinam, generalized.
(Modified from Lexique Stratigraphique International, Vol. V, Amerique Latine, Surinam, by H. T. L. van Eijk, 1962.)

Age	Unit	Lithology
Holocene to Recent	Corantyne System (Upper Part) Demerara Series	Clays, marine, some with organic material and shell sands. River and creek alluvium.
Pleistocene	Corantyne System (Middle Part) Lelydorp Sands	Sand, yellow to white.
	Coropina Series	Clays, grey to bluish-grey to red spotted, marine.
Tertiary	Corantyne System (Lower Part) Bauxite Formation	Sands, pebbles, clays, rich in kaolin, mixed marine and continental sediments.
Mesozoic	Young Dolerite Group	Gabbros, dolerites, basalts.
Paleozoic or Mesozoic	Wilhelmina Rhyolites	Rhyolites and quartz porphorys.
Precambrian, Paleozoic, or Mesozoic	Roriama Formation	Sandstones, quartzites, conglomerates, and tuffs.
Precambrian or Paleozoic	Old Dolerite Group	Dolerite dikes, metamorphosed.
Precambrian	Taffra Group	Garnet-staurolite-mica schists, sillimanite, kyanite, and andalusite occur locally.
	Rosebel Series	Quartz, conglomerate, subgraywacke matrix, quart-sericite schists and phyllites.
	Paramacca Series	Amphibolites, amphibole schists, quartzitic schists andesites, dacites.
	Nassau Series	Lavas, volcanic agglomerates, tuffs, some quartzites, ultrabasic rocks, gabbros.
	Maabo Group	Phyllites, red to purple.
	Gros Group	Metamorphosed sediments, pelitic to psefitic, abundant sericite.
	Granite 3	Bi-mica microcline granites and paragranodioritic gneisses.
	Granite 2	Quartz diorites and gneisses, including migmatites.
	Granite 1	Inferred, present in French Guiana, hypothetical quartzites and conglomerates.
	Gakaba Group	Quartzites and conglomerates.
	Fallawatra Gneiss	Sillimanite, cordierite and garnet bearing gneisses.
	Bonnidoro Series	Metamorphosed fine-grained sediments and metarhyolites.

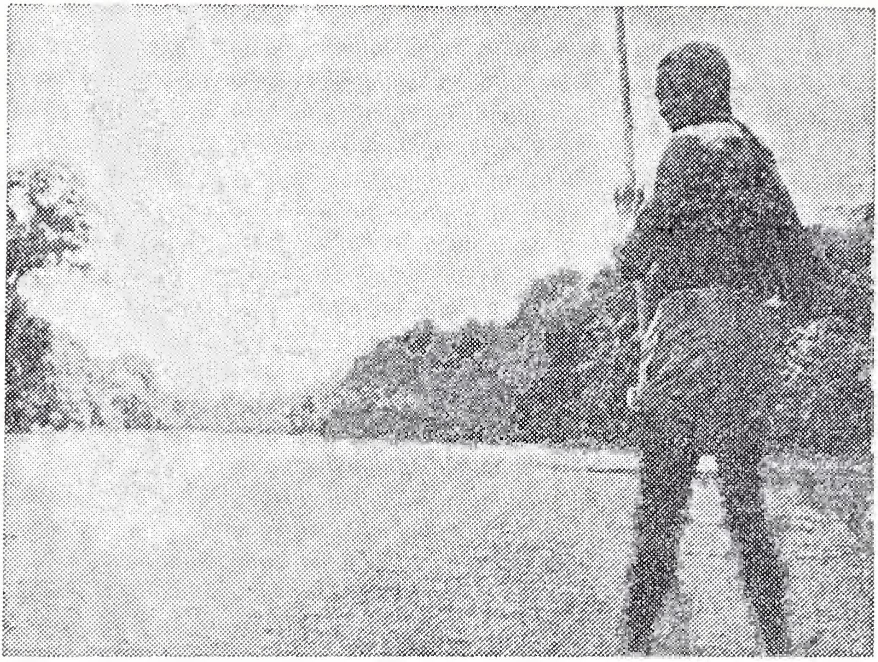

FIGURE 5. The Saramacca River looking southward toward the deep interior.

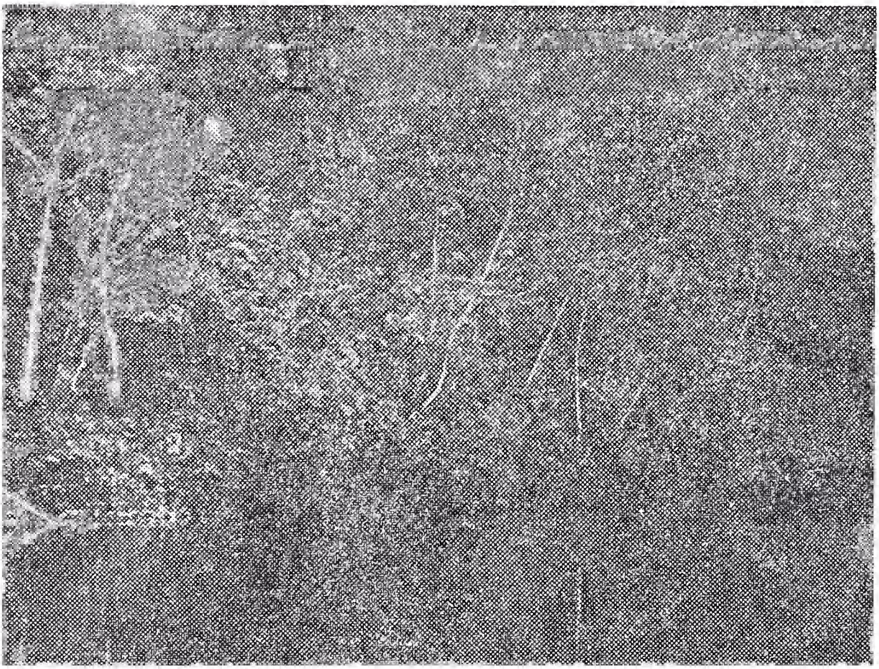

FIGURE 6. Dense tropical growth along one of the major rivers in the interior.

FUTURE DEVELOPMENT

The Surinam government recognizes that a sound fiscal climate, conducive to private investment, will help promote a healthy and stable economy. A well balanced investment ordinance is in effect and it is designed to encourage private investments.

Mining laws are liberal, especially in the granting of concession rights and mining permits. Punitive mining laws do not exist and mining machinery can be brought into the country duty free.

Labor is plentiful and inexpensive. Skilled equipment operators can be found in the country and will increase as mining becomes a major industry.

The scientific organizations, the GMD and PEMI, have done much in adding to the geology of the country. It is certain that Surinam will enhance its economy largely by development of its mineral potential.

ACKNOWLEDGMENTS

Grateful acknowledgment is extended to Dr. Gus Doeve, Director, Surinam Government Geological and Mining Service, and Dr.

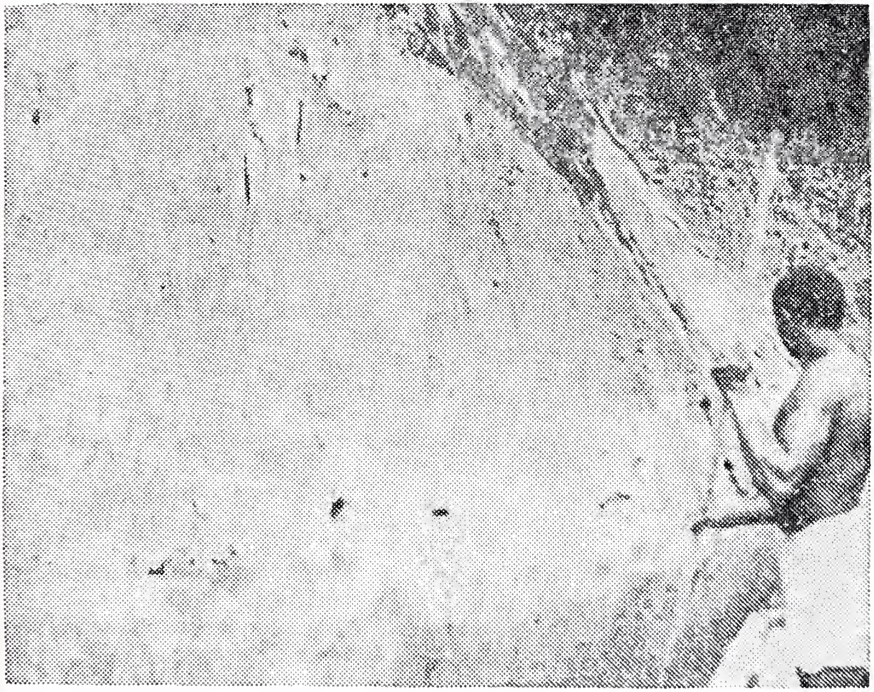

FIGURE 7. Steeply dipping beds of weathered schist or phyllite exposed on the bank of a river.

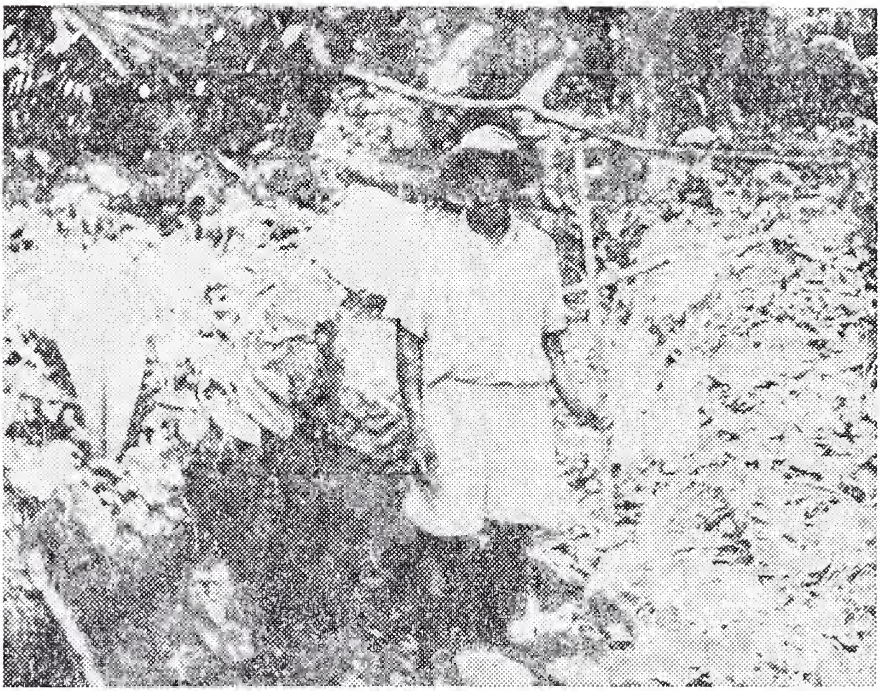

FIGURE 8. Outcrop of gold-bearing quartz vein near Goensie.

C. Van Kooten, Director, Surinam Government Petrographic, Ore Studies, and Mineralogical Institute in Paramaribo, who discussed the general geology of the country with the writer and furnished many details pertinent to specific areas. Acknowledgment is also extended to Dr. L. Krook, Sedimentologist, and Dr. L. O'Herne, Geomorphologist, for assistance in interpreting the geologic and geomorphic maps and terms, and general discussions of the geology of different areas in Surinam.

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Design Considerations For A High-Current Hemispherical Cathode

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INTRODUCTION

Hypervelocity projectiles impacting on targets of various materials have been studied for several years with high-speed photographic methods in the visible range. More recently, those involved in developing military equipment such as armaments and rocketry have become interested in what happens inside the target during and immediately following a hypervelocity impact. Some of the desired information is: how does the shock wave propagate through the material and how do internal separations begin and spread. Flash x-ray systems which produce x-ray pulses with durations in the nanosecond region are being used in many testing programs to give shadowgrams of the impact event on films. These systems suffer from the fact that any one x-ray tube gives only one x-ray pulse during an impact. If multiple shadowgrams are required, several tubes must be used and the resulting shadowgrams each give a different viewing angle. At least one attempt has been made to take multiple shadowgrams from a single viewing angle using a long duration x-ray pulse and an image recording system with submicrosecond time resolution (1).

One of the problems encountered in the development of the multiple-shadowgram system was the inability of available flash x-ray tubes to give an x-ray pulse of sufficient intensity lasting throughout the impact event. The following discussion concerns the design of a thermal cathode for an experimental x-ray tube that is planned to supply sufficient x-ray intensity and pulse durations of 20 microseconds or more.

Cathode Requirements

Tests of existing high-current x-ray tubes indicate that anode-to-cathode arcing is a serious problem. These tubes, which utilize field emission or thermally-enhanced field emission, have closely spaced electrodes which tend to allow an arc to form after a few microseconds of operation. In order to prevent arcs, the electrode separation must be increased. A suitable separation for pulse times of 20 microseconds or more would be so large that field emission is negligible making the cathode emission entirely thermal. Tests also indicate that the cathode must be capable of supplying several hundred amperes in order to be of use in the experimental system (1).

A system producing sharp shadowgrams must have a small x-ray source or be located a great distance from the object of interest and the recording device. A small x-ray source may be obtained from an electron beam with a small cross sectional area. In this case, the small cross sectional area electron beam is to be produced by means of the cathode shape and a focusing electrode feeding into a capillary tube. The cathode is to be hemispherical which, in addition to aiding the focusing scheme (2,3), will provide a large emissive area for the cross sectional area viewed by the anode.

Cathode emission should be reasonably uniform over the entire cathode area which means the cathode temperature should be uniform. Uniform temperature in turn requires uniform spacing of the cathode elements or a complex electrical heating scheme. Calculations will be made which will define element configurations that will give uniform spacing.

Since the tube is experimental, it will be made demountable so that internal configuration may be changed with relative ease. The cathode material must be capable of withstanding the evacuation process repeatedly without losing or changing emission efficiency.

Briefly, the requirements of the cathode may be summed up as follows:

1. The cathode must be a thermal emitter.
2. The cathode must produce several hundred amperes.
3. The cathode must aid in focusing the electron beam.
4. The cathode must have uniform emission over its entire surface.
5. The cathode must operate in a demountable tube.

CATHODE MATERIAL AND AREA

There are several high emission cathode materials available such as boron, thoria, and various other oxides. Most of these materials require special preparation or must be activated each time the tube is evacuated, which makes them undesirable in this particular application (4). Due to the high voltages involved, consideration must also be given to cathode bombardment by high energy ions. Many high current density materials suffer serious loss of emission when subjected to ion bombardment (5).

Tungsten was chosen as the cathode material. Although it is not a relatively high efficiency emitter, it possesses many characteristics required in this application such as: ease of preparation, ability to withstand ion bombardment, ability to withstand the evacuating process repeatedly, and availability in a relatively pure form.

Uniform emission from the cathode surface requires uniform heating of the cathode material. After considering various schemes it was concluded that one of the easiest ways to accomplish uniform heating over a hemisphere was to construct the cathode of equally spaced wire elements of equal length. The spacing can be accomplished by a spiraling method discussed later. Elements of equal length require equal voltages for maintaining a given temperature by the Stefan-Boltzmann equation,

$$P = KT^4. \tag{1}$$

Power dissipation in a resistive circuit is given by the equation,

$$P = VI. \tag{2}$$

If we combine equations 1 and 2 we arrive at this equation,

$$VI = KT^4 \tag{3}$$

which reduced the problem of temperature control to one of voltage control.

The tungsten area necessary to produce a given current may be calculated from Richardson's equation.[5]

$$I_s = AT^2e-^{(b/T)} \tag{4}$$

where: I_s = emission current density,
A = a constant,
b = a constant,
T = temperature in °K.

For tungsten, $A = 60.2$ amps/cm^2/(°K)^2, $b = 52.4 \times 10^3$(°K), and I_s is given in amps/cm^2. The operating temperature has been chosen as 2800°K as a compromise between emission current and life. Substitution of the constants for tungsten into equation 4 allows the calculation of the emission current density for tungsten.

$$I_s = 3.53 \text{ amps/cm}^2$$

The length of tungsten wire of a given diameter necessary to emit a required current may be calculated by equating total emission current, I_e, with the product of emission current density, I_s, and wire surface area, $\pi D1$.

$$l_t = \frac{I_e}{I_s \pi D} \tag{5}$$

Calculations for five sizes of tungsten wire have been made using equation 4 and data from tungsten characteristics by Jones and Langmuir (5). The results are given in Table 1. The heating current in column three is the required current through each element.

If several elements are operated in parallel, the heating current must be multiplied by the number of elements to obtain the total heating current. The length given in column two is the total required length and may be obtained from a number of shorter elements. The table has been compiled for tungsten wire capable of 100 amperes thermal emission when operated at 2800°K.

TABLE 1. Tungsten wire capable of emitting 100 amperes at 2800°K

Diameter (mils)	Total length (inches)	Heating current (amperes)	Resistance 2800°K (ohms)	Voltage gradient (volts/inch)	Heating power (kw)
10	140	7.4	59.3	3.14	3.25
20	70	21.1	7.4	2.23	3.26
30	47	38.9	2.2	1.85	3.26
40	35	59.5	.92	1.56	3.25
50	28	83.3	.47	1.41	3.26

Cathode Configuration

Two of the requirements for this cathode are that it be hemispherical in shape and that it have equally spaced elements. A sketch of a possible cathode is shown in Figure 1. Construction methods require some type of holding fixtures at the top and bottom of the cathode to secure the elements. An assembly cap, which consists of two radially-grooved washers clamped together with a bolt, is used at the top of the hemisphere. The assembly cap holds the top of each element as shown in Figure 2. The bottom of each element is bolted to a mounting ring at the diameter of the hemisphere. Conductivity of the holding fixtures will cause some cooling at the ends of the wire elements; however, experience with experimental cathodes indicates that no more than 10% of the cathode area will be appreciably below the average temperature.

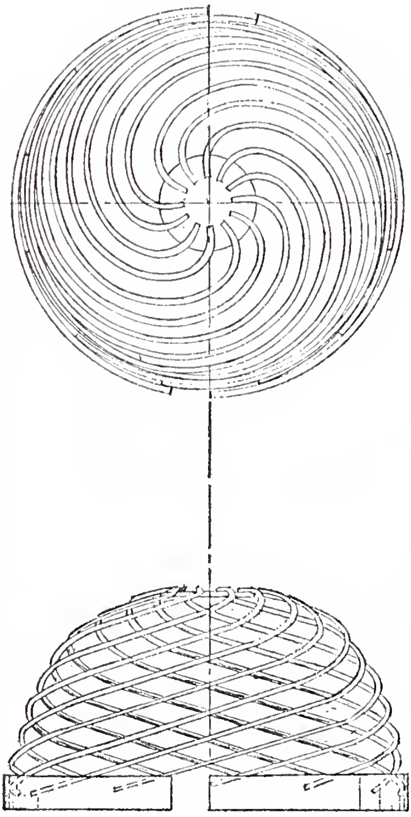

FIGURE 1. Hemispherical cathode with twelve elements.

The distance between two adjacent elements along the perimeter of the assembly cap shown in Figure 2 is given by

$$dp = \frac{2\,\pi\,r}{n} \tag{6}$$

where r = radius of assembly cap,
n = number of elements (or short wires).

The length, d, of a straight line between two adjacent elements at the cap is given by

$$d = \frac{2\,\pi\,r\,k}{n} \tag{7}$$

where k is the proportionality constant between the chord length and the arc length for n elements; that is,

$$k = \frac{\text{chord length}}{\text{arc length}}.$$

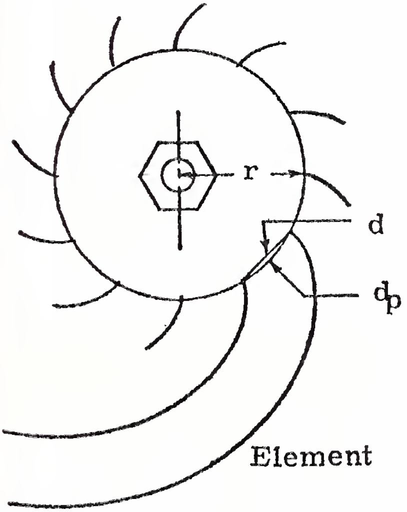

FIGURE 2. Cathode assembly cap.

The value of d is not the exact perpendicular distance between elements, but it is a close approximation for large n, and since the cathode must have uniform emission over the entire hemisphere, n may be assumed to be large. Equation 7 will be used in subsequent calculations as the perpendicular distance between elements.

An approximate differential equation will now be derived describing the position coordinates (or shape) of the wire elements.

The distance, in any plane parallel to the equatorial plane, between adjacent elements is given by

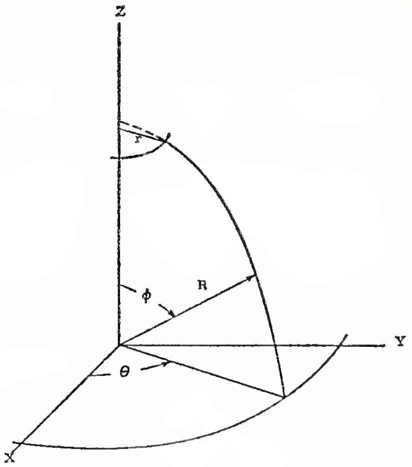

FIGURE 3. Coordinates and radii.

$$d_2 = \frac{2\,\pi\,R\,k\,\sin\phi}{n}$$

(Refer to Figures 3 and 4.) (8)

where R = radius of hemisphere,

ϕ = angle between the z axis and the radius vector to point D or E on Figure 4.

It should be noted that the proportionality constant, k, in equation 8 is the same as in equation 7 because the elements have the same angular separation.

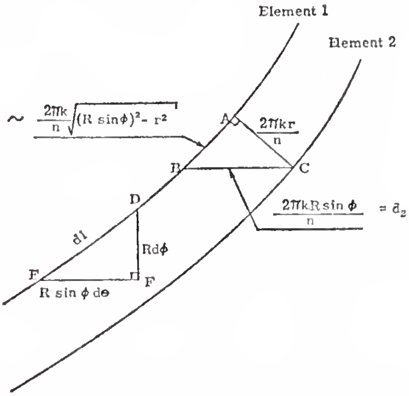
Element 1
Element 2
$\sim \frac{2\pi k}{n}\sqrt{(R\sin\phi)^2 - r^2}$
A
$\frac{2\pi kr}{n}$
B
C
$\frac{2\pi kR\sin\phi}{n} = d_2$
D
dl
$Rd\phi$
E
F
$R\sin\phi\, d\theta$

FIGURE 4. Space relationships between adjacent elements.

Adjacent spiral elements are shown in Figure 4. The triangle, ABC, drawn between adjacent elements and the differential triangle, DEF, may be shown to be similar triangles in the following manner.

If n is large, side AB will approximate a straight line. Angles B and E will then be identical by construction as will angles A and F. Angles C and D are therefore identical, and the triangles are similar.

The following equations result from ratios taken with corresponding sides of similar triangles.

$$\frac{R\sin\phi\, d\,\Theta}{\frac{2\,\pi\,k}{n}\sqrt{R^2\sin^2\phi - r^2}} = \frac{R\,d\,\phi}{\frac{2\,\pi\,k}{n}\;r} \qquad (9)$$

$$\frac{dl}{\frac{2\,\pi\,k}{n}\;R\sin\phi} = \frac{R\,d\,\phi}{\frac{2\,\pi\,k}{n}\;r} \qquad (10)$$

Equation 9 may be solved to give the position coordinates (or shape) of each element spiral around the hemisphere. Equation 10 gives the radius, R, of the hemisphere in terms of the element length, l, which will be necessary for construction purposes.

Pattern

Formation of the cathode wires will be greatly simplified if there is a pattern to shape them by. The results of equation 9 might be rather difficult to plot on a hemispherical pattern without special equipment, but there is an easy method of plotting the spiral to a good approximation.

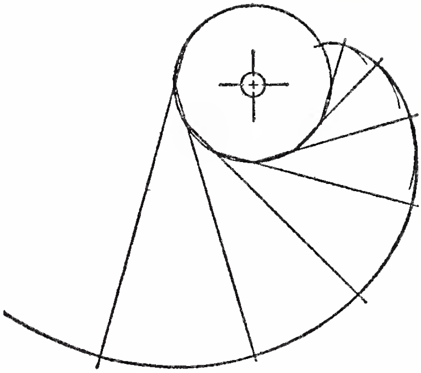

FIGURE 5. Spiral drawn by successive radii.

First the hemispherical pattern is made using the radius obtained from equation 10. Following Figure 5, the pattern is marked with the dimensions of the assembly cap and the number of elements. With a compass, an arc is drawn from the beginning point of one element with a radius taken from the beginning point of an adjacent element (noted here as the second element). The arc is continued until it passes a line drawn from the beginning point of the third element through the beginning point of the second element. The arc continues from this line with a radius taken from the beginning point of the third element. This process is continued until the last arc meets the radius of the hemisphere at the diameter.

Prototype

A cathode was constructed by the pattern method using 30 mil tungsten wire. The parameters from Table 1 were used with proper factors to give 300 amperes emission. Operating at the prescribed heating power, the cathode temperature was measured at 2800°K. Less than 10% of the element length was below 2800°K due to thermal conduction of mounting fixtures.

SUMMARY

In summary, a method has been presented for the design of a high-current hemispherical thermal-emission cathode with relatively uniform emission over the surface of the hemisphere. Differential equations for the shape of the wires were derived and a simple geometrical construction method was described.

Such a cathode has been constructed for use in a flash x-ray tube. The current-voltage-temperature relations have been verified and the measurement of other characteristics will soon be carried out.

ACKNOWLEDGMENTS

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Changing Age Composition Of Tennessee Valley Farmers And Its Effect On Future Farm Numbers

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Age composition is a basic demographic characteristic of any population and is of fundamental importance for such an occupational group as farm operators. If agricultural programs are to succeed they must be constructed in light of the age characteristics of the population toward which they are directed. Previous studies have shown that age differentials influence acceptance of innovations by farm operators, occupational and geographic mobility, and willingness to assume risk.

The objectives of this paper were to describe changing age patterns of farm operators in the Tennessee Valley and to project the age distribution to 1970.[1] Methods of analysis used are techniques developed by Kanel[2] and expanded upon by Tolley and Hjort.[3] These techniques are based upon observations of changes in the age distribution of farm operators and how these changes relate to changes in total numbers of farmers.

This approach arbitrarily groups age segments into categories of persons born within 10-year periods and traces these groups as they advance in age. Each group is called a cohort and the analytical technique employed is referred to as cohort analysis. In this study cohorts are labeled by the census year in which the cohort's members reach the age 15-24.

Changing Age Patterns

A study of Table 1 shows that farm numbers generally increased in the Tennessee Valley prior to 1940 and have decreased since that time. An examination of the age distribution of the farm operator population reveals proportionally more farmers in the younger age groups during the period from 1910 to 1940. Since that time, proportionally more farm operators have been older. This phenomenon, i.e., the change in the age distribution and its effect on total farm numbers, is the basis of this study.

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[1] The Tennessee Valley is defined as the 125 counties wholly or partly within the Tennessee River watershed.

[2] Kanel, Don, "Age Components of Decrease in Number of Farmers, North Central States, 1890-1954," *Journal of Farm Economics,* Vol. XLIII, No. 2, May 1961.

[3] Tolley, G. S. and Hjort, H. W., "Age Mobility and Southern Farmer Skill – Looking Ahead for Area Development," *Journal of Farm Economics,* Vol. 45, No. 1, February 1963.

Data in Table 1 were used to develop cohort patterns shown in Figure 1. Differences in cohorts can be described by two means: (1) by comparing the relative numerical size of cohorts, and (2) by comparing the pattern of cohorts (slopes). A measure of the relative size of cohorts is found by comparing the number of farmers in a given age category (e.g., 35-44) with the same category of each other cohort. Sizes of different age categories of cohorts from 1910 through 1940 can be compared in Figure 1. Size of the 35-44 age categories ranges from a low of 44.0 thousand farm operators in the 1940 cohort to a high of 71.6 thousand for the 1930 cohort. The 1910 and 1920 cohort sizes were 67.7 thousand and 66.7 thousand, respectively.

Cohort patterns generally exhibit an increase in size through age 35-44 and decline afterward. This has not always been the case in the Tennessee Valley as shown by the curves representing 1910 and 1940 cohorts. The 1910 cohort did not reach its largest numerical size until its members were 45-54 years of age or until the 1940 census. The curve began to flatten during the 1920 to 1930 decade when nonfarm jobs were more attractive than farming, but failed to decline after 1930 as would normally be anticipated. Rather, the curve exhibited a moderate upward slope – signifying a higher rate of entrance than withdrawal even at this advanced age. This trend is generally attributed to the depression which affected all cohort patterns by discouraging established farmers from leaving agriculture, offering little opportunity other than farming for rural youth, and forcing many people to return from nonfarm occupations.

TABLE 1. Number of farm operators in the Tennessee Valley by age of operator, 1910-1959, with projections for 1970

Year	Age groups						
	Under 25	25-34	35-44	45-54	55-64	65 and over	Total
1910	24,494	63,742	72,890	66,988	41,019	25,969	295,102
1920	24,683	64,295	73,423	70,986	45,034	29,875	308,296
1930	26,867	56,497	67,694	73,803	50,331	32,102	307,294
1940	17,745	58,365	66,660	70,726	56,546	42,484	312,526
1950	12,440	48,862	71,609	65,662	54,717	46,903	300,193
1959*	3,718	20,040	43,973	58,303	46,137	42,109	214,280
	(3,293)	(18,149)	(40,607)	(52,727)	(41,771)	(37,125)	(193,672)
1970†	2,600	5,900	17,300	34,600	37,500	32,100	130,000
	4,800	7,000	19,200	37,900	38,400	32,700	140,000

Source: Censuses of Agriculture.

* Number of farms in 1959 based on 1950 census definition of a farm. The number of farms according to the 1959 definition are shown in parenthesis.

† The estimates for 1970 are based on the 1959 census definition of a farm. Estimates of age distribution are shown for two sizes of farm operator population in 1970.

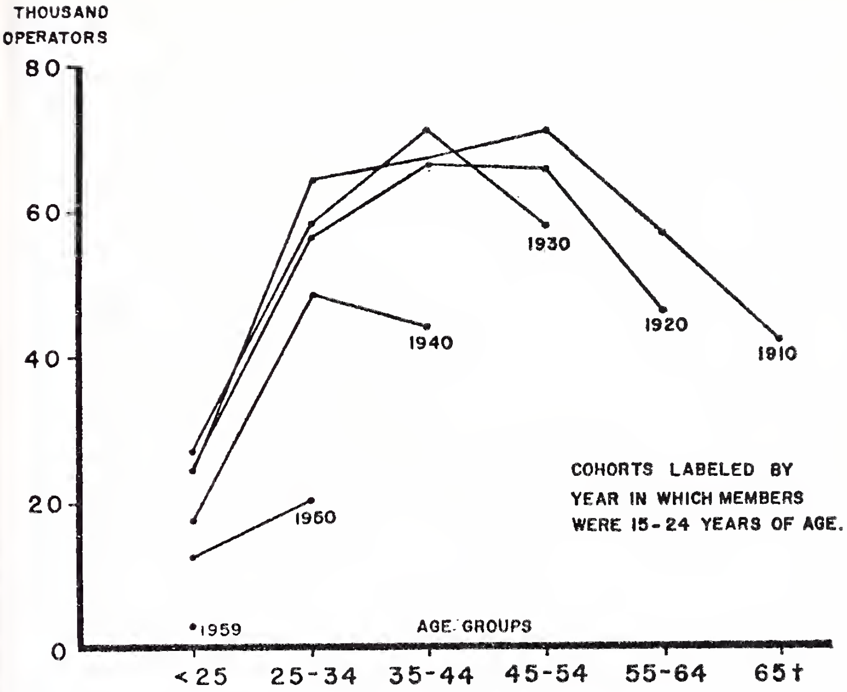

FIGURE 1. Number of Tennessee Valley farm operators in five cohorts.

The 1940 cohort reached a numerical peak when its members were 25-34 years of age and decreased sharply from 1950-1959. This means there were more farmers in this cohort when its members were 25-34 years of age than at any other time. A probable explanation is that many World War II veterans (members of the 1940 cohort) returned to the farm during a period of favorable farm profits only to leave once more as occupational and "GI Bill" educational alternatives were offered.

The general flattening-out of cohort patterns in recent years indicates fewer young people are entering agriculture. Also, cohort patterns appear to reach a peak at an earlier age. This indicates that more farmers 25-34 years of age are leaving agriculture than are entering.

Age Components of Change in Farm Numbers

The decline in farm numbers during recent years corresponds with the increase in net rate of withdrawal of older farmers (45 years and older) and a decrease in the net rate of entry of young people.[4] Data in Table 2 show that during 1930-1940 — the decade of the great depression — net entry of young farmers exceeded net withdrawal of old farmers, resulting in an increase in total farm numbers. The trend was reversed during the 1940-1950 decade when net withdrawal exceeded net entry.

TABLE 2. Rates of change in total number of farmers and its components, Tennessee Valley, 1930-1940

Period	Change in total number of farms	Net entry	Net withdrawal
		(Percent)	
1930-1940	1.7	19.3	17.6
1940-1950	− 3.9	18.2	22.1
1950-1959	−28.6	2.2	30.8
1959-1970	−32.9	2.2	35.1

The most dramatic change occurred during the 1950-1959 decade. A net entry of 6,429 young farmers was countered by a net withdrawal of 92,342 older farmers, resulting in a tremendous reduction in farm numbers. The relatively small net entry during 1950-1959 and the projected net entry during 1960-1970 loom even more significant when contrasted to the net entry of 56,801 young farmers during the 1940-1950 decade. Although net entry occurred within the younger age groups in the entire Valley during the 1950-1959 decade, regional rates of entry show the Valley portions of Alabama and Mississippi with an actual net withdrawal in the younger age groups.

Declining Entry of Farm Boys into Agriculture

The proportion of farm-reared boys entering agriculture can be estimated by comparing the number of young farm operators to the number of farm boys in the same cohort. For example, the number of farm operators aged 15-24 in the 1959 Census of Agriculture can be expressed as a percent of the rural-farm males 5-14 years of age taken from the 1950 Census of Population. Thus, a proportion of the farm boys 5-14 years of age in 1940 was counted as farm operators under 25 years of age in the 1950 Census of Agriculture and 25-34 years of age in the 1959 census.

For a given area such as the Tennessee Valley there is, of course, some interregional migration of farm operators both into and out of the area. It appears reasonable, however, that interegionally relocated farm operators make up a relatively small proportion of the total, and that they would tend to neutralize each other between areas within a 10-year period.

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[4] The term "net" is used in connection with entry and withdrawal because both entry and withdrawal occur continuously during a decade within all age categories. Gross, or total, interchange of the farm population is not obtainable from the data; therefore, net differences are used throughout.

The 1950 Census of Population revealed that 160,030 males between the ages of 5 and 14 lived on farms. By 1959, 3,718 (2.3 percent) had become farm operators. Of the 204,243 farm boys who were 5-14 years of age in 1940, 6.1 percent started farming by 1950, and another 3.7 percent became farm operators by 1959. Thus, 9.8 percent of the young males living on farms in 1940 became farm operators by 1959. In comparison, 22.8 percent of the boys living on farms in 1930 became farm operators by 1950. The number of farmers as a percent of the number of farm boys in the same cohort is shown in Table 3.

Career Adjustment Analysis

Tolley and Hjort formulated a method for quantifying the relative adjustabilities of farm operators of different age groups by means of regression analysis using census data dating back to 1910.

The hypothesis is that the number of farmers in a given age group depends on the number 10 years younger a decade earlier and on the change in total number of farm operators of all ages. The following equation reflects this hypothesis in a form suitable for logarithmic line fitting:

$$\frac{X_t}{Y_t - 10} = a\left[\frac{Z_t}{Z_t - 10}\right]^b$$

TABLE 3. Number of farm operators as percent of number of farm boys in the same cohort, Tennessee Valley*

Cohort†	No. of rural farm boys 5-14 years of age	Number of farm operators by age as percent of number of farm boys		
		Under 25	25-34	35-44
1940	(1930)‡ 214,745	(1940) 8.3	(1950) 22.8	(1959) 20.5
1950	(1940) 204,243	(1950) 6.1	(1959) 9.8	--- ---
1959	(1950) 160,030	(1959) 2.3		

Source: Census of Population; Census of Agriculture.

* The year associated with each percent is contained in parenthesis.

† Cohorts are defined by specifying the period in which members were 15-24 years of age.

‡ The 1930 Census of Population does not give a county breakdown of age distribution of rural-farm population by sex. However, the age distribution of the rural-farm population is reported, and the sex distribution by counties can be obtained and applied to the total population. Thus, the number of rural-farm boys 5-14 years of age in 1930 is actually an estimate.

Where X_t is number of farm operators of a given age group, $Y_t - 10$ is cohort value 10 years previously, and Z_t and $Z_t - 10$ are total numbers of farm operators. The parameter *a* may be interpreted as a normal cohort ratio between adjacent age groups in that it is the ratio in absence of change in total number of farm operators. The *a's* obtained by considering different age groups give the cohort pattern of net entry and exit in absence of aggregate change in farm numbers. This formulation visualizes the observed cohort patterns to result from a normal pattern as subjected to modification in each past decade by changing farm numbers. The parameter *b* gives the modification. It is the elasticity of the number of farm operators in an age group with respect to total farm numbers.[5]

Using this technique, a regression was run for each age group. The parameters *a* and *b* for each group are presented in Table 4. Results obtained for all farm operators in the Tennessee Valley correspond generally with those obtained by Tolley and Hjort for whites in the South as a whole.[6] Since the Valley has relatively few non-white farm operators, these findings appear consistent.

The greatest response to changes in total number of farm operators occurs within the younger age groups; i.e., a 1-percent change in the total number of farm operators yields a 4.68-percent change in the number of farm operators less than 25 years of age (column 4 of Table 4). The response declines sharply with advancing age groups, but the response is significant at the .05 level or better up through the 45-54 age group.

TABLE 4. Regression results for Tennessee Valley farm operators†

Farm operator age group, X	Correspondent age group ten years earlier, Y	Ratio (a)	Effect of one percent change in total number of farm operators (b)	Correlation coefficient (r)
Under 25‡	25-44	.15**	4.68**	.97**
25-34	Under 25	2.42**	1.14*	.79
35-44	25-34	.87**	.67*	.85
45-54	35-44	.99	.59**	.94*
55-64	45-54	.73**	.05	.14
65 and over	55-64	.77**	—.01	.03

* Significant at .05 level.

** Significant at .01 level.

† The format of this table is similar to that used by Tolley and Hjort, and the components are interpreted similarly.

‡ The "under 25" age group has no correspondent age group ten years earlier in the farm operator population. It was supposed that members of this group tend to be sons of farm operators who were 25-44 years of age ten years earlier. For further discussion, see Tolley and Hjort, *op. cit.*, p. 34.

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[5] Tolley and Hjort, *op. cit.*, page 33.

[6] Tolley and Hjort, *op. cit.*, page 34.

The coefficients obtained from the regression analysis were used to estimate the age distribution of farm operators in 1970. These estimates are contained in Table 1.

Indications are that by 1970 farm numbers will decline to between 130,000 and 140,000.[7] Assuming 130,000 farms in 1970, the age distribution reveals that relatively few farm operators will be less than 35 years of age – 6.6 percent compared with 11.1 percent in 1959 and 20.4 percent in 1950. Many more farm operators will be 55 years of age and older by 1970 – 53.5 percent compared with 40.8 percent in 1959 and 33.8 percent in 1950.

An estimate of age distribution was also made based on 140,000 farm operators in 1970.[8] These estimates reflect the differences in coefficients obtained for each age group; i.e., as farm numbers were increased from 130,000 to 140,000, the largest relative increase occurred in the younger age groups (Table 2). This implies that when farm numbers decrease from 140,000 to 130,000 the largest relative decrease occurs in the lower age group. Thus the young farm operators, primarily, respond to pressures to adjust. The important fact to note here is that the Tennessee Valley has relatively few of the "more mobile" young farm operators.

CONCLUSIONS

Assuming conditions remain relatively constant during the next two or three decades, rates of entry among younger age groups will replace only a small percentage of older farmers who leave agriculture, resulting in further declines in farm numbers. Estimates show that the 64,000 decrease in farm operators from 1959 to 1970 will result from a net withdrawal of 68,000 operators over 45 years of age and a net entry of only 4,000 under 45 years of age.

Although relatively large numbers of older farmers will retire, the average age of all farmers will increase significantly during the 1960-1970 decade. The modal age group of Valley farmers increased from 40 years in 1950 to 50 years in 1959. Table 1 estimates reveal that the modal age by 1970 will be 60 years. The portion of this population under 45 will be only about 20 percent of the total by the low estimate.[9] In 1959 those under 45 years of age constituted some 32 percent of this population.

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[7] Based on the Tolley and Hjort high-low percentage decrease in white farm operators in the South, there will be approximately 125,000 to 137,000 farm operators in the Valley in 1970. When regressing the total number of farm operators in the Tennessee Valley with time, the equation obtained yielded 137,000 as the number of farmers for 1970.

[8] As treated here, total farm numbers in 1970 are somewhat arbitrary and of secondary importance. Here, total population size is treated as given and the resultant change in size of specific age groups was determined.

Those who will constitute the bulk of farm operator population a decade from now are already well-established farmers. Career commitments have been made and are almost inalterable by the time farmers reach their forties. Most Tennessee Valley farm operators are already this old or older, and will withdraw only through retirement or disablement. As has been indicated, relatively few young people will enter their ranks in the years to come. Consequently, the farm operator population will become older as it becomes smaller.

This "abnormal" age distribution will probably exist for at least another 20 years after which it will right itself somewhat. Until that time, farm policy and agricultural program must be developed and oriented toward an older population that those dealt with in the past.

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[9] The low estimate intuitively seems more realistic to the author.

The Structure Of Commercial Banking In Alabama

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Several studies on the structure of commercial banking in the United States have appeared in recent years.[1] However, less research has been done on the structure of banking systems in individual states. This paper will review the structure of commercial banking in Alabama with particular emphasis on the period since World War II.

From a system of only 39 banks with total resources of $5,036,764 in 1880,[2] Alabama's commercial banking system had expanded to one consisting of 242 banks with aggregate resources of $2,854,324,000 at the end of 1963. After reaching a total of 107 banks in 1900, the state's banking system experienced steady growth until a peak was reached in 1919 when Alabama's 67 counties were served by 358 commercial banks having total resources of $235 million. Banking resources reached a high of $377 million in 1929.

As a result of widespread bank failures in 1920's and early 1930's, there were only 203 banks with total resources of $211 million operating in the state at the end of 1933. From a total of 221 banks at the end of 1934 the number of banks in the state increased gradually to 239[3] at the close of 1958. A merger in 1959 reduced the number of banks to 238. Banking resources in Alabama passed the one billion dollar mark in 1944, and in 1958 banking resources exceeded two billion dollars for the first time.

Banking in Alabama has shown steady growth in the post-World War II period. As indicated by Table 1, total banking resources increased from $1,298,686,000 at the end of 1946 to $2,854,324,000 at the close of 1963. This represents a 120 per cent increase compared with a gain for the nation as a whole of only 98 per cent during the same period. This significantly greater relative increase of banking

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* I am grateful to W. Jack Duncan for his assistance in collecting data for this article.

[1] Recent Developments in the Structure of Banking. Special Staff Report of the Board of Governors of the Federal Reserve System submitted to the Select Committee on Small Business, United States Senate, January 5, 1962, and Changes in Banking Structure, 1953-62, Federal Reserve Bulletin, September 1963.

[2] William W. Cox. The Development of Banking in Alabama (unpublished thesis) Stonier Graduate School of Banking, Rutgers University. 1950.

[3] U.S., Federal Deposit Insurance Corporation, Annual Report, 1944-1960.

resources in Alabama must be interpreted, however, in terms of Alabama's lower starting base. In terms of absolute change, Alabama's banking resources increased only slightly more rapidly than for the nation as a whole during the period 1946-1963. At the end of 1946 Alabama banks held .767 per cent of the nation's total banking resources and by the end of 1963 this figure had increased to only .785 per cent of the national total. However, in a period of rapid national economic growth, it is noteworthy that Alabama banking resources advanced even slightly faster than the national average.

Table 1 also shows the sharp changes in the uses and sources of banking resources in the state. In the postwar period the most pronounced change in the use of bank funds in Alabama has been the greatly increased percentage of total resources represented by loans and the substantial reduction in the percentage of funds held in cash and U.S. Government securities. At the end of 1946 loans accounted for only 20 per cent of total banking resources in the state. By the end of 1963 loans had increased to 46 per cent of total banking resources. During the same period the percentage of bank funds held as cash declined from 26.6 per cent to 17 per cent while investment in U.S. Government securities were reduced from 44.7 per cent to 23 per cent of total bank resources. These changes in the use of bank funds reflect the state's steady economic growth since 1946. As opportunities for loans increased, banks in the state shifted their funds from lower yielding government securities to more profitable loans to both businesses and individuals.

The greatest change in the source of bank funds since 1946 as shown in Table 1 has been the greater percentage of funds provided by time deposits and the corresponding decrease in the percentage of bank funds represented by demand deposits. At the end of 1946 time deposits provided only 19 per cent of the state's total banking resources, while demand deposits accounted for 75 per cent of total bank resources in Alabama. Time deposits increased markedly during the postwar period and at the end of 1963 they represented 32.24 per cent of total bank resources. Demand deposits have advanced much less rapidly since World War II and provided only 57.33 per cent of total banking resources in the state at the end of 1963. Since that time the percentage of funds provided by time deposits has increased by 50 per cent while demand deposits increased by only 8.5 per cent. Time deposits held by Alabama banks increased by 207 per cent between the end of 1946 and the end of 1963. During the same period demand deposits increased by only 67.9 per cent. Much of the growth in time deposits has taken place since 1960.

TABLE 1. Comparative statement of conditions of all insured commercial banks in Alabama* December 31, 1946 and December 20, 1963 (amounts in thousands of dollars)

	Amount	Per cent	Amount	Per cent
	1946		1963	
Assets				
Cash and balances with other banks	346,190	26.66	484,039	17.00
U.S. Government securities	580,597	44.70	654,894	22.92
Other securities	99,275	7.64	356,763	12.50
Loans and discounts	260,427	20.05	1,309,035	45.84
Bank premises, furniture and fixtures	8,773	.68	41,245	1.45
Miscellaneous assets	3,424	.27	8,348	.29
Total assets	1,298,686	100.00	2,854,324	100.00
Liabilities				
Demand deposits	975,165	75.08	1,636,401	57.33
Time deposits	248,323	19.12	920,191	32.24
Miscellaneous liabilities	5,542	.43	45,289	1.59
Total liabilities	1,229,030	94.63	2,601,881	91.16
Capital Accounts				
Capital stock	24,271	1.87	72,534	2.54
Surplus	28,344	2.18	101,565	3.56
Undivided profits	12,588	.97	64,252	2.25
Reserves	4,453	.35	14,092	.49
Total capital accounts	69,656	5.37	252,443	8.84
Total liabilities and capital accounts	1,298,686	100.00	2,854,324	100.00

* In 1946 there were three noninsured banks with resources of approximately 2.3 million dollars. All banks in the state held membership in the Federal Deposit Insurance Corporation at end of 1963. (See FDIC Annual Report for 1946 and 1963.)

Source: U.S. Federal Deposit Insurance Corporation, Report of Call: Assets, Liabilities, and Capital Accounts, Commercial and Mutual Savings Banks, No. 26, December 31, 1946, and No. 66, December 20, 1963.

POSTWAR EXPANSION OF BANKING OFFICES

Since 1946 there has been a strong expansion in banking offices in Alabama. At the end of that year the state was served by 219 banks, five of which operated 23 branches to give the state a total of 242 banking offices. This is shown in Table 2 which summarizes the changes in the number and types of banks or bank offices in Alabama for the period 1946-1963.

Reference to Table 2 also reveals that in the immediate postwar years the number of banking offices grew very slowly. Between 1946 and the end of 1950 only six new banks and three additional branches were established to bring the total number of banking offices in the state to 251. The growth of banking offices in the state accelerated after 1950 with 12 additional banks and 21 new branches being established during the period 1950-1955. The 44 banking offices added during the period 1955-1960 resulted from the organization of one new bank and 43 new branches.

Bank office expansion has moved at a still faster pace since 1960

TABLE 2. Changes in the number and types of banks or bank offices in Alabama, 1946-1963

Type of bank or office	1946	1950	1955	1960	1963
Total Bank Offices	242	251	284	328	371
Banks	219	225	237	238	242
National	66	70	69	69	73
State	150	155	168	169	169
Member of Federal Reserve System	19	23	25	24	24
Nonmember of Federal Reserve System	131	132	143	145	145
Unit Banks	214	219	221	214	207
National	62	65	56	51	50
State	149	154	165	163	157
Banks Operating Branches	5	6	16	24	35
National	4	5	13	18	23
State	1	1	3	6	12
Branches	23	26	47	90	129
National	22	25	43	77	105
State	1	1	4	13	24

Source: U.S. Federal Deposit Insurance Corporation, Annual Report. 1946, 1950, 1955, 1960, 1963.

with six new banks and 39 new branches being established during the first three years of the current decade. Thus, at the close of 1963 the state had a banking system consisting of 242 banks with 35 of these operating 129 branches for a total of 371 banking offices. While official data on the number of new branches added in 1964 are not available, the *American Banker* reports that a record number of five state banks and six national banks were opened in Alabama in 1964 to bring the state's total to 251 banks.[4] With the continued expansion of branches, indications are that at the end of 1964, Alabama had not less than 400 banking offices.

Despite the increase in banking offices in recent years, at the end of 1963 there was only one banking office for every 9,022 people in the state. This high ratio of population to banking offices is exceeded only in the states of Florida, Illinois, and West Virginia, none of which permit branch banking. A recent study suggested that the large population per banking office indicates that banking facilities in the state are inadequate.[5] However, the large number of persons per banking office in a state does not, in itself, reliably indicate the adequacy of its banking facilities. In the case of Alabama it is chiefly a reflection of the stage of economic development in the state, the distribution of income among the state's population, and of the state's restrictive branch banking law.

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[4] American Banker. Vol. 130, No. 21 (February 1, 1965), pp. 1 and 9.

[5] George E. Lent. The Changing Structure of Commercial Banking. Tuck Bulletin 24; Hanover, New Hampshire: The Amos Tuck School of Business Administration, Dartmouth College, July, 1960.

BRANCH BANKING IN ALABAMA

Most of the recent increase in banking offices in Alabama has come about as a result of the expansion of branch banking. Table 2 shows the growth of banking offices in the state. It points out that the number of banks operating branches increased from 5 to 35 and that the number of branches expanded from 23 to 129 during the period 1946-1963. Three banks, First National Bank of Birmingham with 22 branches, the Birmingham Trust National Bank with 13 branches and the State National Bank of Alabama of Decatur with 17 branches, accounted for 40 per cent of the 129 branches in operation at the end of 1963.

Prior to 1911 Alabama was among the states in which branch banking was permitted by state authorities "merely because the law was silent on the subject."[6] Although branch banking was practiced to a limited extent in the state no reference to branch banking is found in the Alabama Codes before 1911.[7] In passing "An Act to Create A Banking Department" in 1911, the legislature included a provision forbidding branch banking.[8] This act did not apply to banks having branches at that time. The State National Bank of Alabama with branches in 15 towns located in 11 counties was the only such bank in operation in 1963.

In January 1935, the legislature passed what is known as a general law with "local" applications which permitted branch banking in Jefferson County. This law enabled two of Birmingham's largest banks to absorb two smaller banks that had become over-extended.[9] Since that time, similar laws have been enacted to permit branch banking in 28 of the state's 67 counties. Thus, Alabama has a branch banking law that restricts branch operations to the county of the parent bank with the exception of the State National Bank of Alabama.

OTHER CHARACTERISTICS OF BANKING IN ALABAMA

An outstanding characteristic of commercial banking in Alabama is the large number of relatively small unit banks. Out of 242 banks in the state on December 31, 1963, 155 had deposits of less than five million dollars, 80 had deposits which ranged from five to 50 million dollars, and seven had deposits in excess of 500 million dollars. Table 3 groups commercial banks according to deposit size and shows the percentage of total deposits in the state held by banks in the various deposit groups. It shows that Alabama's largest bank held 16.49 per cent of all the bank deposits in the state at the end of 1963 and that the six largest banks held 43.6 per cent of total deposits. The difference in the size of banks in the state is more clearly seen when it is noted that Alabama's largest bank held slightly more deposits than the state's 155 smallest banks at the end of 1963. Seven Alabama banks held almost half of the total deposits in the state on the same date.

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[6] Shirley Donald Southworth. Branch Banking in the United States. First edition; McGraw-Hill Book Co., New York. 1928. p. 20.

[7] General Provisions as to Banks and Banking, Code of Alabama 1907, Article 9, Sections 3518-3527. Also, Free Banking Corporations, Code of Alabama 1876, Article VIII, Sections 1944-1990.

[8] General Laws of the Legislature of Alabama, Session of 1911, p. 77.

[9] Wallace Davis Malone, Jr. Commercial Banking in Alabama 1947-1957. (unpublished Master's Thesis) Wharton School of Business, University of Pennsylvania. 1959. p. 157.

Concentration of bank deposits is also found in metropolitan areas. The largest bank in Birmingham held 58 per cent of all the deposits in the city at the close of 1963. While this represents a decline from 68 per cent of Birmingham's banking resources at the end of 1959, Alabama's largest city is still ranked as one of the most highly concentrated banking cities in the nation.[10]

Also to be noted is the 100 per cent membership in the Federal Deposit Insurance Corporation by Alabama banks. Unanimous participation was obtained in 1950. Only 15 states had achieved 100 per cent F.D.I.C. membership in 1963.

Another noteworthy feature of Alabama's commercial banking system is the large number of single bank communities. At the end of 1963, there were 142 municipalities which had but one bank.[11] As might be expected, most of these banks were small. Eleven had

TABLE 3. Alabama commercial banks grouped according to amount of deposits, December 31, 1963

Deposit size, millions of dollars	Number of banks	Total deposits, thousands of dollars	Per cent of state total
Less than 1	14	10,213	.39
1 to 2	39	60,306	2.39
2 to 5	102	352,516	13.50
5 to 10	52	356,318	14.43
10 to 25	18	259,464	9.09
25 to 50	10	360,767	13.80
50 to 100	1	72,617	2.79
100 to 200	4	477,332	18.28
200 to 300	1	231,307	8.84
300 to 450	1	430,133	16.49

Source: Southern Bankers Directory 1964: Special Alabama Edition, Southern Banker of Atlanta.

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[10] Commission on Money and Credit, Private Financial Institutions. Prentice-Hall, Inc. 1963. pp. 150-155.

[11] Southern Banker, Southern Bankers Directory 1964: Special Alabama Edition, Atlanta, Georgia.

deposits of less than $1,000,000. Eighty-five had deposits that ranged between $1,000,000 and $5,000,000 and only 46 had deposits in excess of $5,000,000. As Malone noted in his study, single bank communities have been on the increase in the postwar period.[12] In 1947 there were only 109 such communities, but by the end of 1963 banking facilities had been extended to an additional 33 towns. This increase in single bank towns does not reflect a series of mergers, but rather it is an indication that banking services have been made available to a greater number of communities.

STATE AND NATIONAL BANKS

Largely because of the predominance of small banks and the less restrictive state banking laws, national banks have always been outnumbered by state chartered banks in Alabama. Since 1946 the number of new state banks has increased much faster than the number of new national banks (Table 2). In 1946 there were 66 national banks in the state and by the end of 1963 this number had increased only to 73. During the same period, state chartered banks grew from 150 to 169. The more rapid increase in state banks can be explained by the fact that most banks organized during the period were in towns of 3,000 or less population.[13] The state law requires capital of only $25,000 in communities of this size while national banks would be required to have capital of $50,000.

While state banks exceed national banks by more than two to one, national banks accounted for approximately 72 per cent of the banking resources in the state at the end of 1963. Resources held by state banks totaled only $802,291,000 while resources in national banks amounted to $2,052,033,000.[14] In addition to 73 national banks in Alabama there were 24 state banks with resources of $195,369,000 that were members of the Federal Reserve System. Thus, 97 banks which account for 78.74 per cent of Alabama's banking resources are subject to Federal Reserve regulations. All banks in the state are governed by the regulations of an instrumentality of the federal government since all banks in the state are members of the Federal Deposit Insurance Corporation.

ALABAMA'S FINANCIAL CENTERS

Birmingham, Mobile, and Montgomery are the financial centers of the state. Birmingham's four banks with 44 branches and total deposits of $738,319,000 represented by far the largest concentration of banking resources in the state at the end of 1963.[15] The First National Bank of Birmingham with total deposits of $430,133,000 at the end of 1963 accounted for 16.49 per cent of all bank deposits in Alabama. When the $308,186,000 of deposits in the other three Birmingham banks in 1963 are included it is found that banks in the state's largest city held 28.28 per cent of all bank deposits in the state. The city of Mobile with three banks having 10 branches and total deposits of $321,603,000 or 11.27 per cent of the state's total ranks second as a financial center. Montgomery with four banks operating six branches and having deposits of $193,236,000 or 6.77 per cent of the state's total represents the third largest concentration of banking resources in Alabama.

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[12] Malone, *op. cit.*, p. 51.

[13] Malone, *op. cit.*, pp. 139-142.

[14] U.S. Federal Deposit Insurance Corporation, Report of Call: Assets, Liabilities, and Capital Accounts, Commercial and Mutual Savings Banks, No. 66. December 20, 1963.

RECENT GROWTH

Table 1 noted the strong growth in banking resources in Alabama since World War II. While banks expanded their resources by 120 per cent in the period 1946-1963, closer analysis indicates that the rate of growth during the decade of the fifties was much more rapid than during the immediate postwar years. For the four years 1946-1950 banks added to their resources at an average annual rate of only 1.34 per cent. Resources grew at the much faster rate of 5.50 per cent a year for the period 1950-1960. A growth rate of 5.87 per cent per year was recorded by Alabama banks for the first half of this period. Despite two economic recessions during the years 1956-1960, banks in the state were able to increase their resources at an average annual rate of 5.18 per cent. During this same five year period all commercial banks in the nation grew at an average annual rate of only 4.16 per cent. With an increase in resources of 387 million dollars or 15.67 per cent in 1963, banks in Alabama continued to maintain a growth rate higher than the national average which came to 13.33 per cent for the last year covered by this study.

CONCLUSION

Alabama's banking resources have increased at a slightly faster rate than for the nation as a whole in the postwar period. There has been a strong trend toward increased banking facilities both through the expansion of branch banking and through the organization of new unit banks. An expanded banking system should contribute to continued economic growth in Alabama in the years ahead.

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[15] Southern Bankers Directory 1964, *op. cit.*

Spanish Military Commanders In Colonial Alabama

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Spain's bright lion and castle banner flew for the second time over Alabama when young Bernardo de Gálvez conquered Mobile from the British in 1780. From that year until General James Wilkinson lowered the Bourbon banner from Mobile in 1813, Alabama formed part of West Florida. The various settlements were ruled from Mobile under the general orders of the governor-general of Louisiana and West Florida with headquarters in New Orleans. Of the numerous unsung Spanish military commanders who helped guard the approaches to Spain's *Mare Nostrum,* the Gulf of Mexico, several were superlative administrators, some were average, and a few were erratic. They all faced many difficulties in governing a non-Spanish population on a dangerous frontier and wrote their daily records which have survived the ravages of time to enable us to discover what colonial Alabama was like.

The first two Spanish commandants of Mobile rule for relatively short periods. José Emanuel Ignais Timoteo Espaleta (Ezpeleta) y Galdeano was born in Barcelona in 1742, the son of Captain Joaquín de Espaleta y de Castillo of the Infantry Regiment of Castilla, and of María Ignasia de Espaleta Galdeano y Prado. After earning the rank of colonel and sargent-major of the Navarre Infantry Regiment in 1776,[1] José de Ezpeleta fought in the Gálvez campaigns against Mobile and Pensacola and during 1781 was commandant of Mobile.[2] He married María de la Paz de Enrile of Genoa, Italy, in the same year.[3] Ezpeleta was later ad-interim governor of Havana in 1785, and following the death of Gálvez in 1786, he became captain-general of Cuba and of Louisiana. He stayed in Havana until 1789.[4]

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[1] Ezpeleta's *expediente matrimonial,* November 24, 1784, Archivo General Militar de Segovia (Spain).

[2] Josef de Ezpeleta to Pedro Juzan, Mobile, February 19, 1781, in Lawrence Kinnaird (ed.), *Spain in the Mississippi Valley,* Vols. II-IV, American Historical Association *Annual Report for 1945* (3 parts; Washington, 1946-1949), Pt. 1, 420-21; Translated Records, Mobile Probate Court, I, 156-57.

[3] Two of their children were Field Marshal José de Ezpeleta, born in Havana, and María de los Angeles, born in Bogotá, who married Colonel Pedro Salazar y Varona in 1828. Service record of José de Ezpeleta (Jr.), Archivo General Militar de Segovia; Enrique de Ocerin (ed.), *Indice de los expedientes matrimoniales de militares y marinos que se conservan en el Archivo General Militar (1761-1865)* (Madrid, 1959), I, 172.

[4] *Expediente matrimonial* of José de Ezpeleta, Jr., Archivo General Militar de Segovia; *Colección de documentos inéditos para la historia de Hispano-*

Enrique de Grimarest exercised command of Mobile and its district from March 17, 1780 until succeeded by Ezpeleta the following year. He later served from 1781 until 1785 when illness forced him to surrender command of Mobile. He subsequently moved to Campeche. He had married Ana Narbona in 1782. Among his important services at Mobile were the approval of numerous land grant applications for early settlers and participation in the vital Indian conferences at which treaties were signed in Mobile and Pensacola during 1784.[5]

A native New Orleanean succeeded Grimarest at Mobile. Pedro Joseph Favrot was born in 1749 and joined the French army at the tender age of eleven. He transferred to the Spanish Louisiana Infantry Regiment on November 20, 1778 at the rank of captain and fought during the Manchak and Baton Rouge campaigns. After commanding at Baton Rouge he assumed the commandancy of Mobile in 1785. Two years later he was replaced, despite petitions from the inhabitants who asked Governor-general Esteban Miró to keep him at Mobile. Named commander of Natchez troops in 1792, his disputes with Governor Manuel Gayoso de Lemos resulted in his transfer to the posts of San Phelipe de Placaminas and Balize, which guarded the entrance of the Mississippi below New Orleans. His pro-French sympathies prevented him from rising beyond the rank of lieutenant-colonel in the Spanish army, but he was known as a good officer and a loving father. He wrote a textbook in arithmetic for his sons Luis and Philogene, and his diaries, which recorded life in Spanish Louisiana, have won him the sobriquet, "a Creole Pepys." He retired from the army in 1808, but continued to live in Louisiana.[6]

Few officers who served in Spanish Louisiana and West Florida

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América, Vol. XII, *Catálogo de los fondos cubanos del Archivo General de Indias* (Madrid, 1930), 1, appendix.

[5] *Expediente matrimonial* of Grimarest, 1782, Archivo General Militar de Segovia; Helen Parkhurst, "Don Pedro Favrot, a Creole Pepys," *Louisiana Historical Quarterly*, XXVIII, No. 3 (July, 1945), 700-702; Land grants, Translated Records, Mobile Probate Court, I, 16-27; Treaty of Mobile; June 22-23, 1784, and Treaty of Pensacola, July 13-14, 1784, Archivo General de Indias, Papeles de Cuba (hereafter abbreviated as AGI, PC), leg. 2360; service record, 1787, Archivo General de Simancas, Guerra Moderna (hereafter abbreviated as AGS, GM), leg. 7296, IV, 1.

[6] Favrot's service record, June 30, 1795, AGI, PC, leg. 161-b; December 31, 1797, AGS, GM, leg. 7292, X, 17; Petition of Favrot to Captain-general of Cuba, Baton Rouge, December 15, 1808, with accompanying documents, AGI, PC, leg. 1659; W.P.A. Historical Records Survey, *The Favrot Papers* (12 vols.; New Orleans, 1940-1963); Parkhurst, "Don Pedro Favrot," 679-734; Translated Records, Mobile Probate Court, I, 26-43.

evidenced more belligerence toward his fellow-officers, nor guarded his sovereign's rights with greater zeal than Vicente Folch y Juan.[7] Born in Reus, Spain on March 8, 1754, Folch entered military service as a sub-lieutenant of light infantry in 1771. He studied mathematics and engineering at the Royal Military Academy of Barcelona and won his spurs during the African campaigns of 1774-1775 as well as the siege of Gibraltar in 1780. Sailing to America with the Army of Operations, he served for a few weeks as ad-interim commandant of Mobile. He resumed command of that post in July, 1787 and remained there until May, 1790. He commanded again in 1791 until replaced the following year. Folch is credited with establishing Ft. San Esteban de Tombecbé on the Tombigbee, by ordering Josef Deville Degoutin to build a fort there in 1789 to protect American settlers against Indian attacks. He also sent an expedition to capture runaway Negro slaves on the Tensaw River.

Folch conducted an interesting reconnaissance of Tampa Bay in 1793 and for a time served in command of a light squadron of galleys protecting the mouth of the Mississippi against possible attacks from French Jacobins. In 1795 he took command of Ft. San Fernando de las Barrancas, located on the Chickasaw Bluffs at present-day Memphis. Despite numerous disputes with Governor Gayoso, Folch was a capable commandant who kept Indian friendship in a growing hostile environment.

Raised to the command of Pensacola in 1796, Folch served until 1811. He faced the challenge of Indian attacks under William Augustus Bowles and the advancing tide of American settlers. An indulgent father who raised two sons to a military career and two daughters to an education in New Orleans, Folch demonstrated unswerving devotion to a monarchy which allowed him to die penniless in Havana on November 8, 1829.

Manuel Ventura de Lanzós was, perhaps, the most capable of the Spanish commanders of Mobile.[8] Born in the Galician village of Padrón in July, 1739, Lanzós joined the Cantabrian Infantry Regiment in May, 1756. He first served in America after 1761 with the

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[7] Jack D. L. Holmes, "Three Early Memphis Commandants: Beauregard, Deville Degoutin, and Folch," West Tennessee Historical Society's *Papers,* XVIII (1964, 14-26; Translated Records, Mobile Probate Court, I, 44-101, 103-108.

[8] Biographical sketches of Lanzós accompany his diary in Jack D. L. Holmes (ed.), *Documentos inéditos para la historia de la Luisiana, 1792-1810* (Madrid, 1963), 310-55; and Jack D. L. Holmes, "Gallegos notables en la Luisiana," *Cuadernos de Estudios Gallegos* (Spain), Fascículo LVII (1964), 113-16; on his land grant approvals, see Translated Records, Mobile Probate Court, I, 108-53, 201-69.

Cartagena Regiment. Later he fought in the Panama Regiment on the Isthmus and along the Mosquito Coast. He was a lieutenant in 1778 when he left Puerto Rico and the Victorian Regiment to join the Louisiana Regiment. With his wife, Gertrudis Guerrero, and four daughters, Lanzós moved to New Orleans where his small fortune was erased by the disastrous New Orleans fire of 1788.

After campaigning at Mobile and Pensacola during the Revolution, Lanzós was asked to organize the second and third battalions of the Louisiana Infantry Regiment. Commissioned a captain in 1787, he served in New Orleans until 1792 when he was named military and civil commandant of Mobile and its dependencies. In addition to the usual duties of hearing complaints, approving land grant applications, supervising the religious activities of the district, and commanding the military organizations, Lanzós helped preserve the Alabama settlements against Indian attacks and kept a wary eye on possible invasion from the over-zealous American frontiersmen or troublesome Jacobins.

He returned to New Orleans in 1795 because of poor health — an obvious hazard at Alabama posts — and upon his recovery he was employed in organizing a picket of troops. In 1797 he aided Governor Gayoso in defending Fort Panmure de Natchez against a local uprising. Granted retirement with pension the same year, he was again appointed in 1798 to command Mobile, where he remained until 1800.

Pedro Olivier was a trouble-shooter for Indian relations in Alabama and performed his most notable services in this area of diplomacy. Born Pierre Derneville Olivier in New Orleans in 1754, he entered Spanish service as a cadet in 1771 and fought during the 1779 Mississippi campaigns which wrested West Florida from the British. When an expedition to upper Louisiana was attacked in 1783, Olivier helped fight off the attackers. He demonstrated bravery and military skill during another expedition launched from New Orleans to capture runaway Negro slaves in 1784.[9]

Olivier served as special agent and commissary to the Talapoosa and Upper Creeks from 1791 until the upper Alabama posts were evacuated after 1799, and was a prime factor in off-setting the influence of Alexander McGillivray when that Creek leader seemed to favor the Americans. As a captain in the Lousiana Infantry Regiment, Olivier served as commandant of Mobile in 1790 and again from 1795 until 1798. He died on May 8, 1805.[10]

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[9] Service record, June 30, 1793, AGI, PC, leg. 161-a.

[10] Carondelet to Conde de Floridablanca, No. 5, New Orleans, February 16, 1792, Archivo Histórico Nacional, Sección de Estado (hereafter cited as

Born in Ceuta, Africa, on March 1, 1763, Joaquín María Angel Sebastián de Osorno y Viana entered military service as a cadet on May 20, 1777. After serving in the Naples Infantry Regiment, he joined the Louisiana Infantry Regiment in 1779. He fought during the siege of Pensacola in 1781 as ensign of hunters and became captain of grenadiers on January 22, 1807. His influence on Louisiana military affairs was increased greatly by his desirable marriage to Antoinette Marie Joseph de St. Maxent, daughter of Antoine Gilbert de St. Maxent and Elizabeth Laroche, and the sister of Colonel Francisco Maximiliano de St. Maxent, one-time commandant of Pensacola.[11]

After serving as temporary commandant of Ft. San Phelipe de Placaminas in 1794,[12] Osorno was made recruiting officer in Mexico during 1797. He returned to Placaminas in 1799, but the following year he was named commandant of Mobile, where he signed numerous applications for land grants between 1800 and 1806.[13]

The last Spanish commandant of Mobile, who surrendered the post and town to General Wilkinson in 1813, was Captain Cayetano Pérez. He had served in the militia from 1793 until 1795 when he was promoted to lieutenant and adjutant of the Castillo of the Prince in Havana. He returned to Pensacola in 1804 as captain of grenadiers and in 1805 was named captain.[14]

AHN, EST.), leg. 3898; Carondelet's instructions to Olivier, New Orleans, February 8, 1792, AGI, PC, leg. 122-a; Gayoso's instructions to Olivier, New Orleans, January 30, 1798, AGI, PC, leg. 2354; James Seagrove to President of the United States (Washington), Rock Landing, July 5, 1792, *American State Papers, Indian Affairs,* I, 304; Gayoso to Carondelet, No. 5, San Fernando de las Barrancas, August 12, 1795, AGI, PC, leg. 43; Carondelet to Lanzós, New Orleans, May 6, 1795, AGI, PC, leg. 22; Translated Records, Mobile Probate Court, I, 102-03, 174-201.

[11] Service record, June 30, 1793, AGI, PC, leg. 161-a; December 31, 1808, AGI, PC, leg. 161-b; *expediente matrimonial,* 1792, Archivo General Militar de Segovia (hereafter cited as AGMS).

[12] Francisco Collell to Carondelet, Placaminas, July 15, 1794; AGI, PC, leg. 47; Collell to Carondelet, No. 304, Placaminas, August 8, 1794, AGI, PC, leg. 32.

[13] Return of the Louisiana Regiment, November-December, 1797, enclosed in Gayoso to Santa Clara, No. 102, New Orleans, January 23, 1798, AGI, PC, leg. 1501-a; correspondence of Osorno with governors-general of Louisiana from Placaminas, 1799, AGI, PC, leg. 51; Osorno to Marqués de Casa-Calvo, Mobile, 1800-1802, AGI, PC, legs. 71-72, 2367; Osorno to Folch, Mobile, 1800-1806, AGI, PC, legs. 58-61; Deed, Antonio Espejo to Samuel Mims, Mobile, November 16, 1801, witnessed by Joaquín de Osorno, in Washington County Records (Chatom, Alabama), Deed Records of Probate Office, Vol. A, p. 17; Translated Records, Mobile Probate Court, I, 268-300.

[14] Service sheet, AGI, PC, leg. 161-b.

In addition to the commandants of Mobile, numerous officers and subalterns served in the various Alabama posts scattered along the Tombigbee and Tensaw Rivers. Acting under the orders of Folch, the commandant of Mobile, Josef Deville Degoutin Bellechasse established a fort at San Esteban on the Tombigbee River, not far from Alabama's territorial capital of St. Stephens.[15] Deville was born in New Orleans on June 21, 1761, and served during the revolutionary campaigns of the Louisiana Infantry Regiment. From 1786 until 1792 he served in West Florida at various posts, including San Esteban, which he established in 1789. In 1793 he commanded the galley *La Felipa* in the Mississippi Squadron. After serving at San Fernando de las Barrancas from 1796 until its evacuation in March, 1797 Deville returned to New Orleans and married Adelaida María Josefa Lalande Dalcourt and was transferred to the newly established settlement on Thompson's Creek called New Feliciana.

After the Americans occupied New Orleans in 1803, Deville joined the Orleans Territorial Militia as its colonel, but his constant disputes with Governor W. C. C. Claiborne caused him to resign his command and his political positions in the legislature and he ended his days in the Spanish service in Cuba.

Of all the Spanish officers who doubled as Indian agents, the most capable was Juan Louis Fidele Farault de la Villebeuvre. Born in Brittany in 1738, Villebeuvre was commissioned a sub-lieutenant in the Spanish army on February 15, 1767. Before his death in September, 1797, he rose to the rank of lieutenant-colonel. He was married to Jeanne Darby y Corbin, and was the father of a son by the name of Juan.[16]

Villebeuvre had considerable military and political experience. He helped establish the Spanish fort at Natchez in 1767.[17] In 1777 he was commandant of the posts of San Gabriel d'Iberville and Manchak.[18] Two years later he accepted the surrender of the British forces at Natchez and became its first commandant until overthrown by a revolt of British loyalists in 1781.[19]

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[15] Holmes, "Three Early Memphis Commandants," 27. The biography is based on this writer's study with illustration in *ibid.*, 26-37.

[16] Service record, June 30, 1793, AGI, PC, leg. 161-a; pay records, AGI, PC, leg. 538-b; Gayoso to Santa Clara, No. 202, New Orleans, September 27, 1798, AGI, PC, leg. 1501-b; Juan de la Villebeuvre, the younger, died of yellow fever as a cadet in the regiment in 1796. Service record, June 30, 1795, AGS, GM, leg. 7292, II, 138; New Orleans *North American*, June 13, 1915.

[17] Pedro Joseph Piernas to Antonio de Ulloa, St. Louis, June 5, 1767, AGI, PC, leg. 2357.

[18] Juan de la Villebeuvre's inventory of the post of Manchak, October 1, 1777, AGI, PC, leg. 190; de la Villebeuvre to Bernardo de Gálvez, Manchak, May 14, 1778, AGI, PC, leg. 215-a.

Because of his friendship with the Chickasaws and Choctaws, he was able to win these tribes over to Spain, particularly after 1787. He was principal agent to the Choctaws, drawing an annual salary of $850 above his regular pay as captain of grenadiers.[20] In 1791 he served as ad-interim commandant of the Attakapas post.[21]

In 1795, after careful undercover work with the Choctaws and Chickasaws by Villebeuvre, Spain was able to establish an important military post at the Chickasaw Bluffs.[22] He also persuaded the Choctaws to sign the Treaty of Boucfouka in 1793, by which the post on the Tombigbee called Ft. Confederation was obtained. Villebeuvre served as commandant of that post during its formative years and supervised its evacuation in March, 1797.[23] He then took command of Ft. San Esteban and compiled the first census of that post before death ended his distinguished career in September, 1797.[24]

An engineer, charged with the supervision and repair of fortifications at Ft. San Esteban in 1792; Lieutenant Pierre Foucher y Carrière-le-Garin was born in New Orleans on December 31, 1755, the son of Antoine Foucher and Marguerite Carrière. After enlisting in the militia as carabineer on May 1, 1778, Foucher fought in the conquest of forts Manchak and Baton Rouge, and in 1780 demonstrated superior engineering ability at Mobile by supervising the reconstruction of several buildings and the rebuilding of the fortifications. Named commandant of New Madrid in 1789, he helped create the Spanish settlement there until called to San Esteban. In 1793 he succeeded Luis Bertucat as director of fortifications at San Phelipe de Placaminas.[25]

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[19] See correspondence in AGI, PC, leg. 193-a; and various transcripts in the Archivo Nacional de Cuba; John Caughey, "The Natchez Rebellion of 1781 and its Aftermath," *Louisiana Historical Quarterly,* XVI, No. 1 (January, 1933), 57-83.

[20] Service record, 1793; Gayoso to Carondelet, Natchez, April 14, 1792, copy enclosed with Carondelet's approval to Conde de Floridablanca, No. 24, confidential, New Orleans, April 21, 1792, AHN, EST, leg. 3898.

[21] Petition of Antoine Boutte to de la Villebeuvre, Atacapas, April 18, 1791, AGI, PC, leg. 215-a.

[22] Jack D. L. Homes, "Spanish-American Rivalry over the Chickasaw Bluffs, 1780-1795," East Tennessee Historical Society's *Publications,* No. 34 (1962), 50-52.

[23] Treaty of Boucfouka, May 10, 1793, copy enclosed in Carondelet to Alcudia, No. 10, confidential, New Orleans, June 11, 1793, AHN, EST., leg. 3898; another copy of the treaty is in AGI, PC, leg. 2353. See also, Morales to Pedro Varela y Ulloa, No. 9, confidential, New Orleans, March 31, 1797, *ibid.,* leg. 3902; de la Villebeuvre to Carondelet, No. 15, Ft. Confederation, July 7, 1794, in Kinnaird (ed.), *Spain in the Mississippi Valley,* Pt. 3, 315.

[24] The census is dated San Esteban, April 16, 1797, AGI, PC, leg. 64. See also, Carondelet's instructions to de la Villebeuvre, 1795, AGI, PC, leg. 22; and de la Villebeuvre's correspondence as commandant of Confederation and San Esteban in AGI, PC. Consult Roscoe R. Hill (comp.), *Descriptive Catalogue of the Documents of . . . Papeles Procedentes de Cuba* (Washington, 1916), index. On his death, see pay records of his widow, AGI, PC, leg. 538-b.

Federico Auteman served at Ft. Confederation beginning in the fall of 1795.[26] Born in Germany in 1754, he entered Spanish service as a soldier and second corporal on July 3, 1780. After distinguished service during the Mississippi campaign, when he helped repulse an attack by pro-British Chickasaws led by the Colberts, he was promoted to sergeant second-class and first-class in 1784 and 1787 respectively. In 1798 he was commissioned sub-lieutenant of the fifth company of the second battalion in the Louisiana Infantry Regiment, in which he served until his sudden death on May 24, 1799.[27]

Sub-lieutenant Pedro de Rola was commandant of San Esteban between September 9, 1794 and the spring of 1795.[28] Born in Montechiaco, Sardinia in 1746, he joined the Spanish army on January 26, 1772 and was promoted through the ranks to sub-lieutenant of the Louisiana Infantry Regiment by February, 1794. He had served in the Milan Regiment before coming to Louisiana in 1785.[29] When Rola was relieved of command at San Esteban in 1795, he was offered the post of second-in-command at Ft. Confederation, but he declined the position and asked to be transferred to his regiment at Pensacola.[30] In November, 1797 he took command of the Tensaw Post and remained there until after 1799.[31] In 1802 he was director of fortifications at the Pensacola post of San Carlos de Barrancas with a raise in rank to lieutenant. He left Florida in 1814.[32]

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[25] Service record, June 30, 1793, AGI, PC, leg. 161-a; June 30, 1795, AGS, GM, leg. 7292, I, 34; petition of Foucher, New Orleans, March 31, 1797, copy enclosed in Carondelet to Juan Manuel Alvarez, No. 26, New Orleans, April 30, 1797, AHN, EST., leg. 3900. Foucher was married to Francisca Isabel Boré, daughter of Juan Estevan Boré, and Juana Margarita María Detrehan. *Expediente Matrimonial,* AGMS.

[26] Carondelet to Manuel de Lanzós, New Orleans, February 25, 1795, and Carondelet to de la Villebeuvre, New Orleans, September 16, 1795, AGI, PC, leg. 22.

[27] Service records, June 30, 1793, AGI, PC, leg. 161-b; and December 31, 1797, AGS, GM, leg. 7292, X, 80; statement of the Louisiana Infantry Regiment, January 1, 1800, *ibid.*, XV; Manuel Gayoso de Lemos to Conde de Santa Clara, No. 151, New Orleans, June 6, 1798, AGI, PC, leg. 1501-b.

[28] Bassot to Carondelet, San Estevan, September 10, 1794, copy enclosed in Carondelet to Las Casas, No. 639, New Orleans, January 26, 1795, AGI, PC, leg. 1443-b; Carondelet to Lanzós, New Orleans, January 28, 1795, AGI, PC, leg. 22.

[29] Service record, June 30, 1793, AGI, PC, leg. 161-b.

Fernando Lisoro commanded at both San Esteban and Confederation. He began his miltary service in the Aragón Infantry Regiment on January 22, 1755. Born in southern Spain in 1736, Lisoro rose in the ranks to become lieutenant of the fifth company of the third battalion in the Louisiana Infantry Regiment. He served in the garrison at Oran in Africa for six years before fighting the Portuguese in 1762. He first came to Louisiana with the Conde de O'Reilly's punitive expedition of 1769 and remained to fight at Manchak and Baton Rouge. On several occasions he served as commandant of San Esteban and Confederation between 1791 and 1799. On February 5, 1799, he surrendered the keys of the San Esteban to Richard Brashear and evacuated his forces below the thirty-first parallel to Mobile under the terms of the Treaty of San Lorenzo. He died on October 28, 1799.[33]

Not all of Alabama's colonial commandants were paragons of virtue and efficiency. Two who spent almost as much time in trouble as in command were Antonio Palao and Juan Antonio de Bassot. Lieutenant Antonio Palao y Prats was born in Cataluña, Spain, a province noted for its individualists. Born in 1761, Palao entered the Spanish service as a cadet in 1778 after serving seven years of apprentice military service. He joined the Artillery Company of Santa Cruz de Tenerife in the Canary Islands and, in 1779, with eighty-eight recruits from those islands for the Louisiana Infantry Regiment, he arrived at New Orleans. He transferred to the Louisiana Regiment and fought at Mobile and Pensacola, but his bravery was questioned by then-captain (and later colonel of the regiment) Francisco Bouligny, who charged that Palao had hidden behind a wall during an attack.[34]

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[30] Carondelet to Lanzós, New Orleans, January 28 and February 25, 1795, AGI, PC, leg. 22.

[31] Gayoso to Santa Clara, No. 140, New Orleans, May 20, 1798, AGI, PC, leg. 1501-a; letter book of Lanzós to Rola, Nos. 1-17, Mobile, November 18, 1797-November 9, 1798, AGI, PC, leg. 225, and legs. 64-65. Rola witnessed power of attorney between Samuel Mims and William Pierce at Tensaw on February 13, 1799, New Orleans Notarial Records (New Orleans Court House), Notary Pedesclaux, XXXIV, fols. 317-18.

[32] Correspondence of Rola, 1802-1812, San Carlos de Barrancas, AGI, PC, legs. 59-60, 75, 140, 588; report on regiment, December 31, 1809, AGI, PC, leg. 161-b.

[33] Peter J. Hamilton, *Colonial Mobile* (rev. ed.; Mobile, 1952), 511; service records, June 30, December 31, 1793, AGI, PC, leg. 161-a, and December 31, 1797, AGS, GM, leg. 7292, X, 57; list of deaths in regiment, January 1, 1800, in *ibid.*, XV; review of third battalion, Pensacola, April 20, 1798, enclosed in Gayoso to Santa Clara, No. 174, confidential, New Orleans, July 19, 1798, AGI, PC, leg. 1501-b; Carondelet to Lanzós, New Orleans, January 28, February 25, and September 16, 1795, AGI, PC, leg. 22; deposition of John Brewer and Richard Brashear, December 16, 1806, Clarence E. Carter (ed.), *The Territory of Mississippi, 1798-1817*, Vol. V, *Territorial Papers of the United States* (Washington, 1937), 481-82; translated records, Mobile Probate Court, I, 154-56, 174-75, 201-69.

Although he had been promoted to lieutenant in 1789, Palao was soon in serious trouble in an affair involving mishandling of regimental funds. Court-martialed and imprisoned in 1791, he was released two years later to direct fortifications in New Orleans and at San Phelipe de Placaminas, and in 1794 he was again ordered to take charge of military construction at Ft. Confederation.[35]

Frontier fort construction was a difficult task under the best of conditions, and Palao aggravated the situation at Ft. Confederation by constantly arguing with everyone under his jurisdiction. He fought with the carpenter, Antonio Espejo, who fled the irate Catalonian's wrath and later instituted a legal action against Palao.[36] Despite numerous excellent drawings of the fortifications by Palao, Captain Villebeuvre dryly commented that the fortifications were unsuited to the terrain and location.[37]

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[34] Service records, June 30, 1793, AGI, PC, leg. 161-a; December 31, 1797, AGS, GM, leg. 7292, X, 46; Bernardo de Gálvez to José de Gálvez, No. 229, New Orleans, January 15, 1779, AGI, PC, leg. 223-b; Memorial and petition of Palao, New Orleans, December 11, 1803, AGI, PC, leg. 70-b; Carondelet to Las Casas, No. 202, New Orleans, October 1, 1792, AGI, PC, leg. 1441.

[35] Miró to Las Casas, No. 235, New Orleans, August 20, 1791, AGI, PC, leg. 1440. Bouligny accused Palao of "consistent bad conduct" and placed him under arrest in 1793. Memorial of Palao, with comments of Bouligny attached, New Orleans, February 5, 1793, copy enclosed in Bouligny to Santa Clara, No. 236, New Orleans, April 20, 1799, AGI, PC, leg. 1502-a; Bouligny to Carondelet, New Orleans, November 13, 1792, copy enclosed in Carondelet to Las Casas, No. 246, New Orleans, November 18, 1792, AGI, PC, leg. 1441; certification of Carondelet, New Orleans, February 7, 1795, AGI, PC, leg. 22, which stated that the governor-general was well-pleased with the energy and zeal with which Palao directed the fortifications. *Cf.* pay records of Palao, AGI, PC, leg. 538-b. Palao was charged with supplying his men with dried vegetables and treating them harshly. Captain-general Las Casas ordered him imprisoned for one year and warned him if his conduct did not improve, he would be cashiered from the army. Las Casas to Carondelet, Havana, January 3 and 27, 1793, copies enclosed in Bouligny to Santa Clara, No. 236, April 20, 1799. While under house arrest, Palao was nonetheless given command of Placaminas fortifications.

[36] The lawsuit is in AGI, PC, leg. 169.

[37] De la Villebeuvre criticized the efforts of Palao to Carondelet, No. 15,

In the fall of 1794 Palao wrote a pitiful letter to the governor-general, in which he reported that his family was nude and hungry. He implored Carondelet's aid to transfer him to "a small corner where he could plant corn to fill the bellies of his children."[38] Carondelet obligingly sent him to take command of Ft. San Esteban some leagues below Ft. Confederation on the Tombigbee.[39]

Palao showed his gratitude by antagonizing the residents of the new post when he imprisoned a settler named Isaiah White. Carondelet sternly commanded Palao to release White, pay damages, and return confiscated cattle because such treatment would never win friends for Spain.[40] Palao did show some skill in administration when he drafted several regulations for the post and by approving numerous land grants during 1795.[41]

Governor-general Gayoso, who succeeded Carondelet, removed Palao from command at Ft. San Esteban, but the ill commandant was already suffering from chronic syphllis which was being treated with mercury by Pensacola physicians.[42] By 1803 Palao had been discharged and was living on a small pension in New Orleans.[43]

Last, but not least, as far as extraordinary and neurotic behavior is concerned, there is the interesting Alabama career of Lieutenant Juan Antonio de Bassot. Born in the German province of Lorraine in 1747, he enlisted in the Spanish army and fought under Gálvez in the campaigns from 1779 through 1781. He showed unusual bravery in battle and was transferred to Panama where he fought against the British before returning to Spain and joining the Soria Regiment. He came to Louisiana again and was living in Alabama

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Ft. Confederation, July 7, 1794, Kinnaird (ed.), *Spain in the Mississippi Valley*, Pt. 3, 315.

[38] Palao to Carondelet, Ft. Confederation, September 20, 1794, AGI, PC, leg. 30.

[39] Carondelet to Lanzós, New Orleans, January 28, February 25, 1795, AGI, PC, leg. 22.

[40] Carondelet to Olivier, New Orleans, September 25, 1795, *ibid.*

[41] Translated Records, Mobile Probate Court, I, 162-74; *American State Papers, Public Lands*, I, *passim*, see index; Palao's regulation on public safety, San Esteban, April 24, 1795, in English, AGI, PC, leg. 213, and in Spanish in AGI, PC, legs. 31 and 2364.

[42] Bouligny's comments on Palao's petition, enclosed in Bouligny to Santa Clara, No. 236, April 20, 1799; Hamilton, *Colonial Mobile*, and "St. Stephens: Spanish Fort and American Town," *Publications of the Alabama Historical Society, III* (1898-1899), 227, incorrectly states that McClary took Ft. St. Stephens from Antonio Palaas [*sic*] in 1799. On Palao's malady, see Pedro de la Puente's report, Pensacola, February 10, 1796, AGI, PC, leg. 33; Palao's memorial, Pensacola, February 10, 1796, *ibid.*

[43] Palao's petition, New Orleans, December 11, 1803, AGI, PC, leg. 70-b.

in 1786 when he asked legal title to a lot in Mobile.[44] In 1788 he was promoted to sub-lieutenant.[45]

Because of difficulties with his fellow officers in New Orleans, Bassot was given the command of Ft. San Esteban in 1794. His relations with Captain Lanzós, commandant of Mobile, were so filled with problems, that Bassot was ordered to turn his command over to Rola and report to Pensacola within a few months of taking the post. Bassot complied, but rather than take the direct route to Mobile and thence to Pensacola, he borrowed some horses and set out on an impromptu inspection tour of West Florida defenses which stretched over five hundred miles. This action astounded his superiors![46]

Bassot suffered the taunts and teasing of his fellow officers, and even soldiers of the regiment refused to heed his commands. He had an altercation with an Indian woman over eleven barrels of corn and was once accused of stealing horses. Imprisoned on five separate occasions for a total of seventeen months, Bassot was a thorn-in-the-side to governors-general Carondelet and Gayoso who recommended his discharge on charges of mental imbalance. Captain-general Luis de las Casas agreed he was eccentric, but thought him a good officer and refused to recommend his discharge. Physicians who examined Bassot agreed that nothing was wrong except a nervous condition induced by too much frontier fatigue. They recommended a rest in Havana, but Bassot's superiors prevailed and in 1798 Bassot was discharged with a monthly pension of fifteen dollars. He continued to live in New Orleans, however, and hounded his superiors by demanding satisfaction for past imprisonments and insisting on a general courts-martial with witnesses and the elaborate procedures of Spanish justice. The archives are filled with his rambling complaints, but he never received the satisfaction he demanded.[47]

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[44] Service sheets and pay records, AGI, PC, leg. 161-a, 538-b; land grant petition, Mobile, April 27, 1786, Translated Records, Mobile Probate Court, I, 29-30.

[45] Service Records, AGI, PC, leg. 161-a.

[46] Bassot's difficulties at St. Stephens are noted in Carondelet to Luis de Las Casas, No. 639, New Orleans, January 26, 1795, AGI, PC, leg. 1443-b, which includes enclosures as follows: Bassot to Carondelet, San Estevan, September 10, 1794; Bouligny to Carondelet, New Orleans, January 14, 1795; Gayoso to Carondelet, Natchez, December 21, 1794; and Las Casas to Carondelet, Havana, June 29, 1795. See also, Pedro Rola to Lanzós, No. 8, San Estevan, November 12, 1794, and Lanzós to Carondelet, No. 701, Mobile, November 19, 1794, AGI, PC, leg. 30.

[47] Carlos Howard to Gayoso, New Orleans, May 25, 1798, copy enclosed in Gayoso to Santa Clara, No. 151, New Orleans, June 6, 1798, and Gayoso to Santa Clara, No. 164, New Orleans, July 19, 1798, *ibid.*, leg. 1501-b; Gayoso

The Spanish-American frontier had a debilitating effect on many of the officers who served there. Americans who succeeded the Spaniards in Alabama found conditions equally onerous, and the mortality rate was also high. Given these conditions in colonial Alabama, the amazing thing is that more Palaos and Bassots were not the result. Yet a brief analysis of the lives of these commanders shows that Spain was truly interested in the welfare of the settlers living in colonial Alabama and tried hard to administer the colony wisely. Appointing military officers from many countries with various kinds of experience, Spanish policy succeeded in giving colonial Alabamians three decades of stable, honest, and secure government.

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to Santa Clara, No. 140, May 20, 1798, *ibid.*, leg. 1501-a. Regarding Bassot's brushes with his superiors and subordinates, see his courts-martial, enclosed in Carondelet to Las Casas, No. 6, New Orleans, March 20, 1797, AGS, GM, leg. 6927; *expediente* of Bassot, 1800, AGI, PC, leg. 1659; Bassot's statement, New Orleans, October 27, 1791, copy enclosed in Carondelet to Las Casas, No. 131, New Orleans, June 21, 1792, AGI, PC, leg. 1441.

SYMPOSIUM

Resources And Their Development In The Tennessee River Watershed Of Alabama

The Tennessee River Valley In Alabama: Its Geographical Setting

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According to Webster, "Geography is the science of the earth and its life; the description of the earth, its climate, its products, its inhabitants including man, and his industries."

As can be seen from this definition geography is a discipline with many facets. The subject, "The Tennessee Valley in Alabama" will be dealt with under two broad headings, the physical and the human. But in some cases the two will overlap. This paper will of necessity be of a general nature as there will be other papers in this symposium that will treat specific features of the region.

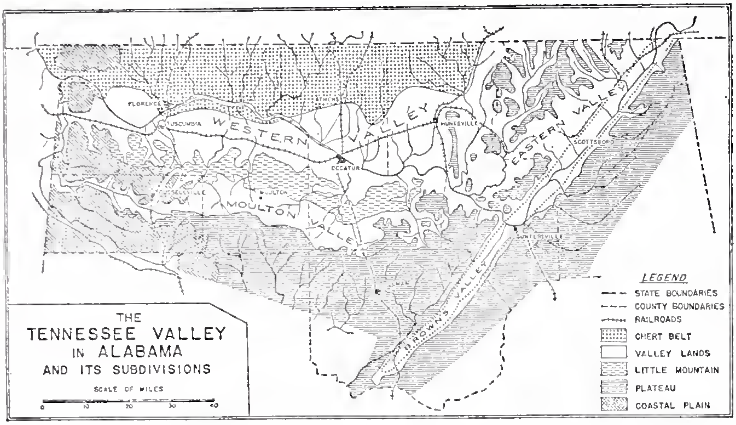
The Physical Setting:

Geometrically, the area is located approximately between 33° and 35° North Latitude and between 85° and 87° West Longitude.

Another way of expressing this fact is to say the area is about 2400 miles from the equator and 3800 miles from the North Pole.

Geographically, the Tennessee Valley is that part of Alabama north of Sand Mountain, a sandstone plateau of Pennsylvanian rock which extends almost across the state. There are small portions, north of the Tennessee River in Jackson, Madison, and Marshall counties that are not considered a part of the Valley. Also near the western boundary of the state both plateau and valley are overlapped by the thin edge of the Tuscaloosa formation, which belongs to a very different region, the Coastal Plains. Brown's Valley makes a narrow tongue or spur of the valley region extending southwest from Guntersville to the southern edge of Blount County. Nineteen different geological formations occur in Jackson County. These formations consist of consolidated material deposited in the ancient seas that once submerged the land. The rocks range from pure limestone of the valleys to sandstone capping the mountains. The eastern and southeastern section of the county is occupied by Sand Mountain. (See map.)

Little Mountain proper, an outcropping of the Hartselle sandstone a formation of the Mississippian age, averages about five miles



wide and has an area of approximately 200 square miles. Its main area is found in Colbert, Lawrence, and Morgan Counties.

The Moulton Valley lies between Little Mountain and the plateau of Sand Mountain. It is an area of Bangor limestone about ten miles wide. Sometimes it is referred to as the Falkville-Moulton-Russeville valley. The surface of this valley is mostly level farm land with a few creeks but no rivers.

The total area of the Tennessee Valley is about 5,000 square miles or approximately one-tenth of the total area of Alabama.

The Tennessee River, a major stream of North America, in its course of 250 miles across Alabama was nowhere less than one-fourth mile wide and averaged about one-half mile in width before the TVA development. It was about two miles wide at Mussel Shoals (sometimes the spelling "muscle" is used). The river's descent was about 250 feet in crossing the state. Approximately one half of the total fall was at or near the Mussel Shoals, where it descended 130 feet in 34 miles, and 85 feet in 15 miles at the steepest part.

The Mussel Shoals were a serious hindrance to river commerce even to the early settlers. In a move to remedy the situation the state of Alabama in the years 1831-36 constructed a canal with 17 locks on the north side of the river alongside the shoals. The canal proved to be unprofitable because of the small amount of tonnage that utilized its facilities. This was due to some extent to the competition from a railroad that had been built from Tuscumbia to Decatur. Since the State Canal was not a financial success, it soon ceased to be used. Renewed interest in the Mussel Shoals canal developed in the 1880's and the federal government constructed a canal that was opened in 1890. With the completion of the Mussel

Shoals canal and a small dam for navigation purposes constructed at Widow's Bar in Jackson County, steamboats could travel the Tennessee River from its mouth to Chattanooga.

Interest in utilizing the Tennessee River for power did not gain much headway until near the end of the 19th century. Alabama chartered the Muscle Shoals Power Company in 1899 and Congress granted the company the right to build a series of dams on the Tennessee River in 1906. However, the company's plans were never carried out. No concrete action was taken to harness the river for power until World War I. As a war measure the federal government built two large nitrate munitions plants and Wilson Dam. The dam was completed in 1926 and flooded the entire area of the Mussel Shoals. Commerce on the river increased and in 1926 amounted to almost two million tons.

The next major river development was carried out under the direction of the Tennessee Valley Authority which was created by the federal government in 1933. The work of this agency is generally well known, and only a few highlights of its operations will be mentioned here.

Two leading economists, Hoover and Ratcheford, have described the program of the Tennessee Valley Authority as ". . . the most ambitious and far-reaching attempt the Federal Government has ever made to bring about the coordinated, integrated, long-range conservation and development of the natural resources of a large area." This program involved the expenditure of millions of dollars of public funds to realize the greatest benefit from the river in terms of flood control, erosion control and abatement, reforestation, recreation, hydro-electric power, navigation, and other direct or allied water uses.

There are four locks and dams on the Tennessee River within the boundaries of Alabama. At Florence is Dam No. 1 which was constructed by the Army Corps of Engineers, completed in 1926 and modified by a height increase in 1948 by the TVA. The Wilson Dam at Muscle Shoals above Florence was begun as a World War I project (as has already been indicated) by the Corps of Engineers and completed in 1926. Eighteen miles above Florence is the General Joe Wheeler Dam, a unit completed by the TVA in 1936. It includes a lock constructed by the Army Corps of Engineers. The remaining installation in Alabama is nine miles below Guntersville and is known as the Guntersville Dam, completed in 1939. Tons of commercial freight moved annually on the Tennessee River increased from less than three million tons in 1933 to more than thirteen million tons.

The average annual home use of electricity in the TVA region as a whole exceeded 10,000 kilowatt-hours per customer in 1963, in contrast with 600 kilowatt-hours per customer in 1933. The average cost was less than a cent per kilowatt-hour, compared with six cents in 1933. In contrast to about a third of a million customers in 1933, more than 1.5 million had electrical service in 1963. Where 1.5 billion kilowatt-hours was generated in the TVA region in 1933, the TVA system in 1963 provided 68.5 billion kilowatt-hours, nearly forty-six times as much.

In 1933 the TVA began work on one kind of fertilizer, concentrated super-phosphate; in 1963 its experimental plants provided substantial quantities of ten different fertilizer materials for use in two educational programs operating in four-fifths of the states in cooperation with land-grant colleges and industry.

Due to the combined efforts of the TVA, the States and their forest services, and many other agencies, a vast change has been brought about within the Tennessee Valley region. Forests now cover 15.2 million acres, a million acre gain since 1933. Fire protection has been extended to 97 per cent of the forest land and has improved in quality; the area burned over each year has declined from about a million acres to 50,000 acres. Over 800,000 acres of eroded and idle land have been reforested. With forests improved to the point where the annual growth exceeds the drain, forest industries have increased at a rapid rate. Over a thousand industries depend upon the Valley's forest for raw material, employing 50,000 persons and having an annual payroll of more than $154 million.

As a part of Alabama's multi-million dollar Inland Docks System, three installations have been made on the Tennessee River. They are as follows:

DECATUR — 227 acres; two 231 × 50 reinforced concrete docks; 18,000 sq. ft. rigid frame warehouse; office, garage, spur tracks to major trunk line; access roads.

FLORENCE — 22 acres; 200 × 54 reinforced concrete dock; 35,000 sq. ft. rigid frame warehouse space; spur tracks to trunk line railroad; access roads.

HUNTSVILLE — 39 acres; 211 × 36 reinforced concrete dock; 21,000 sq. ft. paved open storage space; 18,000 sq. ft. rigid frame warehouse; access road.

Further benefits from the Tennessee waterway may be developed for Alabama out of the plan to connect the Tennessee River with the Warrior-Tombigbee River system, thus shortening by several hundred miles the water route from the continental interior of the Ohio River valley and the Tennessee River valley to the Gulf of Mexico.

Climate:

The average annual precipitation ranges from 49 inches at Decatur to 58 inches at Bridgeport. The wettest months of the year are March and December, the driest September. Only about one-half as much rain falls in September as in March. Snow is not a major problem in the Tennessee Valley in Alabama. Although it falls quite frequently in the winter months the amount ordinarly is light and seldom causes a major transportation problem. Tornadoes are not uncommon and usually occur in the spring.

The growing season (number of frost-free days) for the Tennessee Valley is about 200 days. In comparison, the Gulf Coast area of Alabama has approximately 300 frost-free days.

The monthly average temperature range is from 42°F in January to 79°F in July. Range for the extremes in temperature are from below zero to a little more than 100°F.

Human Aspects:

Eight Alabama counties lie almost completely within the Tennessee River Valley. They are: Lauderdale, Limestone, Madison, Jackson, Colbert, Lawrence, Morgan and Marshall.

Settlement in the Tennessee Valley began around Huntsville about 1804. Joseph and Isaac Criners (brothers) appear to be the first to build cabins at Big Spring. Shortly thereafter John Hunt came from Tennessee and joined them along with other families. When the town was incorporated in 1811 it was given the name Huntsville.

In treaties signed with the Chickasaw and Cherokee Indians in 1805 and 1806 the U.S. Government acquired all rights to certain areas of the Tennessee Valley. Rumors of the rich farm land in the Valley — "Happy Valley" as it came to be called, caused a steady flow of immigrants from the old states. Especially, did settlers come from Tennessee, Virginia, the Carolinas, and Georgia. Families of wealth and culture came from the older states as well as the penniless pioneer from the hill country. Names that were to become famous in Alabama appeared at land sales to purchase the highly desirable farm land of the Tennessee Valley, first at Nashville then at Huntsville. Among the families represented at the early land sales were the Walkers, Popes, Bibbs, Moores, Clays, and McVays. Dr. David Moore built a gristmill and cotton gin at Huntsville as early as 1809. Soon after its founding, Huntsville became the center of settlements in the Tennessee Valley and one of the most influential cities in Alabama.

Athens, located near the center of Limestone County, was incorporated, with limits including 160 acres, by an act of the Alabama Territorial legislature in 1818. The first settler was John Craig from Tennessee. In 1819 Athens was chosen the county seat. The first court house was constructed of hewn logs. Athens and Limestone County have been the home of many men of distinction in Alabama politics.

The area that is now Lauderdale County was included in the territory claimed by both the Cherokee and Chickasaw Indians. The remains of numerous Indian town sites are to be found along this portion of the Tennessee River. Some contain burial mounds and other domiciliary (home) mounds. Interesting examples of earthenware, agricultural implements, and copper objects have been uncovered. Early immigrants to Lauderdale County came from the seaboard states of the old South. Florence, the county seat, was laid out in 1818; and General Andrew Jackson, General John Coffee and ex-President James Madison were among those who owned lots there.

Tuscumbia, the count seat of Colbert County, was incorporated by the legislature under the name of Ococoposa, which is a corruption of the Chickasaw term "Oka Kapassa." This means "cold water" and referred to the big spring in that town. The name was changed by the legislature to Big Spring in 1821; and to Tuscumbia (the name of an Indian chief) in 1822. The first railroad west of the Alleghanies was built from Tuscumbia to the rivers edge, a distance of two miles, in 1831. There are marble quarries near the town of Cherokee and iron deposits are found near Riverton.

The Tennessee River valley has been called the Cereal Belt of Alabama. Although cotton has always played a major role in the economy of the area, cereals produced include corn, wheat, oats, rye, and barley. Poultry and live-stock raising have been on the increase in recent years.

The Tennessee Valley Authority in its program of resource development gave its greatest attention to agriculture in: encouraging soil conservation by promoting terracing and growing cover crops; conducting tests and experimental farms; producing and promoting the use of fertilizer; carrying on research for the development of new and more efficient farm equipment; encouraging the development of pastures and the raising of live-stock; promoting rural electrification and encouraging the installation of home and farm labor-saving equipment; and lastly, promoting better marketing methods.

The Tennessee Valley Authority introduced the largest and most far-reaching program of uprooting an established pattern of indigenous society in American history. Hundreds of families were removed from farms and ancestral homesteads which dated from early nineteenth century. Whole towns and communities were removed including cemeteries. Churches and schools were placed on higher ground. One of the first manifestations of the new era was the improved quality of homes. Social changes brought about by the availability of cheap electricity and other aspects of the TVA program are too numerous to mention in this paper.

In addition to the vast program of the TVA, the Tennessee Valley has been vitally affected by the installations of the United States government at Huntsville. The Redstone Ordinance Plant was activated in 1941; its work expanded in 1943, and its name changed to the Redstone Arsenal. In 1949 the United States Army decided to use the Redstone Arsenal as the major location for missile research and development. The first object to be launched into outer space and recovered, also the first satellite sent into orbit by the United States, were conceived and developed by the scientists at the Redstone Arsenal. The space activities of the United States were reorganized and the space scientists located at the Redstone Arsenal transferred to the National Aeronautics and Space Administration (NASA) in 1959. The George C. Marshall Space Flight Center, located at Huntsville, was dedicated on September 8, 1960.

The programs of the federal government and the increase in industrialization in the Tennessee Valley both played major roles in the population increase in six of the eight Alabama counties in the area in the periods 1940-1950 and 1950-1960. Also, there was a sizeable shift from rural to urban residents. Madison County had by far the greatest increase in population of the Alabama Counties; 61 per cent between 1950 and 1960 (114% urban increase, 11.5% rural increase).

According to data recently released by the TVA, 62 per cent of the total employment in the early 1930's was in agriculture and only 12 per cent in industry. By 1963, 28 per cent of the jobs were in manufacturing while the agricultural percentage had dropped to 18.

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Soil Resources In The Tennessee River Watershed Of Alabama

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SOIL AREAS AND PROPERTIES OF SELECTED SOIL SERIES

The Tennessee River Watershed in Alabama contains soils of five major soil areas (Fig. 1). In the Limestone Valley Area, Decatur and Cumberland soils are dark red, acid, clayey types. They are deep, well drained soils, usually occurring on flat to undulating topography, and are well suited for the production of most crops. Clays in Decatur soils are very high in kaolinite, and contain lesser amounts of vermiculite-chlorite intergrade, quartz, mica and free-iron oxides (1). Cherty Baxter and Dewey soils are important well-drained upland soils of the area. They have loamy brown surface horizons and yellowish-red or red clayey subsoils. Baxter and Dewey soils occur on undulating to steep slopes. Colbert is an extensive problem soil of the Limestone Valley Area particularly in Colbert

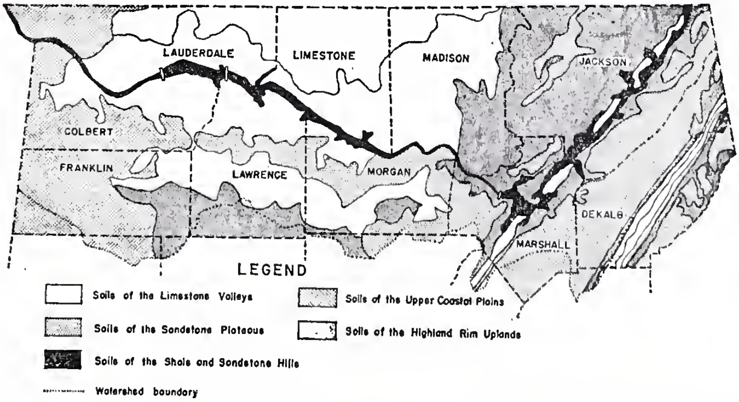
LAUDERDALE
LIMESTONE
MADISON
JACKSON
COLBERT
FRANKLIN
LAWRENCE
MORGAN
DEKALB
MARSHALL
LEGEND
Soils of the Limestone Valleys
Soils of the Upper Coastal Plains
Soils of the Sandstone Plateaus
Soils of the Highland Rim Uplands
Soils of the Shale and Sandstone Hills
Watershed boundary

FIGURE 1. General soils map of the Tennessee River Watershed in Alabama.

county. It has a yellowish-brown, plastic, clayey, surface soil and yellow, plastic, clayey, subsoil mottled with gray. The poor physical condition, poor internal drainage, and hilly to steep topography of Colbert limits its use to pasture and woodland.

Soils of the Highland Rim Area usually are yellow or brown in color, are very high in silt, and usually occupy level to gently sloping topography. Sango and Dickson soils are typical of this area. They each contain a fragipan at about the 18 inch depth that reduces water movement and plant-root penetration in the soil profile. The moderately poor drainage of these soils often limits their use to certain crops and to tree production. Clays in the Dickson and Sango soils are high in vermiculite and kaolinite and contain lesser amounts of montmorillonite, quartz, and probably halloysite. The montmorillonite content is highest in the subsoil horizons of these soils. Baxter and Fullerton soils with a considerable amount of chert occur on the more rolling parts of this area. They are well-drained soils with brown loamy surface horizons and yellowish-red clayey subsoils.

Soils of the Sandstone Plateau Area contain large amounts of fine sand and an appreciable amount of silt, both of which contribute to their capacity to hold a large amount of water available for plants and to their generally favorable physical condition. Although soils of this area generally are low in natural fertility, their good physical properties make them very productive when properly fertilized. The clays in Hartsells and Tilsit soils contain large amounts of vermiculite-chlorite intergrade and kaolinite and smaller amounts of quartz, mica and gibbsite (2). The topography of Hartsells and many other soils of the Sandstone Plateau Area varies from level to strongly sloping. Shallow soils over bedrock occur on the steep slopes. Tilsit soils occur mostly on level to gently sloping topography.

Soils of the Upper Coastal Plains Area in this watershed are largely on steep slopes of winding ridges and are mostly unsuited for cropping. The steep slopes often have mixtures of soils from gravelly, sandy and clayey coastal plains deposits. Guin and Saffell soils comprise a major fraction of this area. They commonly contain about 40 to 90 percent gravel. Cuthbert soils are moderately well drained, have fine sandy loam surface horizons, and have firm clayey subsurface horizons. Lesser amounts of intermediate textured soils, such as Savannah and Ruston, occur on the ridge tops and side slopes of this area. They account for most of the tilled soils of this area.

The Shale and Sandstone Hills Area has soils, such as Hartsells formed from sandstone and more clayey soils formed from shale and limestone. Hartsells or the more clayey Enders occupies many of the ridge tops; shallow soils over bedrock occupy most of the side slopes. The soils on steep slopes are usually sandier near the top of the ridge and more clayey near the valley floor. This change in soils reflects the sequence of parent materials of the area.

Detailed soils maps and information on the morphological properties of soils in this watershed are presented in county soil survey reports prepared by the Soil Conservation Service and other agricultural agencies in the State. These reports are available from Auburn University, Department of Agronomy and Soils and Soil Conservation Service offices.

SOIL QUALITY

The Tennessee River Watershed in Alabama is largely in the 10 most northern counties of the State (Fig. 1). The good quality of much of the land in the watershed area is indicated by its present use (Table 1). Thirty-six percent of the area is being cropped in contrast to 19% for the State (3).

The diversity of land quality in the watershed is indicated by the greater than 40% cropland in Lawrence, Limestone, Madison, and Morgan counties in comparison to less than 30% in Colbert, Franklin, and Jackson counties. A similar distribution within the watershed of good quality land, well suited for cultivation, is indicated by the percentages of classes I and II land (Table 2). Land in capability classes I and II has the least number of limitations regarding its use for cultivation or other agricultural purposes. It is composed of soils that are deep, well drained, and level to gently sloping. Land capability classes III and IV are less suitable for cropping than

TABLE 1. Land-use distribution in the Tennessee River Watershed and in Alabama

County or area	Cropland	Pasture and range	Forest and woodland	Other land	Total acres thousands
		Per cent			
Colbert	20.6	5.7	65.7	8.0	374
DeKalb	34.1	9.2	53.9	2.8	492
Franklin	25.1	5.3	60.7	8.9	406
Jackson	29.4	7.6	61.1	1.9	688
Lauderdale	37.3	7.8	39.6	15.3	414
Lawrence	45.8	16.6	33.4	4.2	342
Limestone	54.5	9.7	24.0	11.8	331
Madison	45.9	17.3	34.3	2.5	436
Marshall	37.1	8.5	47.1	7.3	346
Morgan	43.5	10.7	41.2	4.6	341
Watershed	36.4	9.7	47.7	6.2	4,170
State	19.1	10.0	65.7	5.2	30,616

TABLE 2. Land-capability class distribution in the Tennessee River Watershed and in Alabama

County or area	Classes I & II	Classes III & IV	Classes V, VI, VII
		Per cent	
Colbert	20.4	31.6	48.0
DeKalb	22.5	47.4	30.1
Franklin	14.2	35.2	50.6
Jackson	18.4	36.8	44.8
Lauderdale	39.0	33.9	27.1
Lawrence	36.6	54.6	8.8
Limestone	42.9	45.4	11.7
Madison	43.3	36.5	20.2
Marshall	31.9	33.3	34.8
Morgan	32.8	45.6	21.6
Watershed	29.0	39.7	31.3
Alabama	19.6	38.5	41.9

classes I and II. They are considered suitable for cropping on a limited basis when such restrictions as steep slopes, overflowing and wetness are properly countered. The soils in land capability classes V, VI and VII generally are not suitable for cropping. They are useful for pasture or woodland where steep slopes, shallow soils, excessive wetness and other restrictions are not prohibitive.

Colbert, Franklin, and Jackson counties have the largest proportions of land suitable primarily for pasture and woodland (Table 2) and present use of land for forest and woodland is greatest in these counties.

SUMMARY

1. The Tennessee River Watershed in Alabama traverses five major soil areas and contains soils which differ appreciably in many properties.

2. Counties with large areas of red soils, derived from high grade limestones and soils of the Sandstone Plateau Area have the largest acreages of land suitable for tillage. Also, these same counties have the largest acreages of land used for row-crop production.

3. The watershed has a much higher percentage of cultivated land than does Alabama as a whole.

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Forest Resource And Its Development In The Tennessee Watershed Of Alabama

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During the next 20 minutes I hope to give you a mental picture of the forests which are spread across the top of the State in 15 counties and tell you something of the area's development. This area includes all of the counties partly or entirely within the Tennessee River drainage area.

Industry development in this section, and throughout the State, is most gratifying. In a recent statement, Leonard Beard, Director of the State Planning and Industrial Development Board, reported that "Alabama's 1964 industrial record of $406 million in new and expanding industries puts Alabama ahead of all other states in the Southeast." Of this total, one-third, or $135 million, occurred in the Valley portion or upper one-fifth of the State. This development ranges from metal, chemical, and wood products to industries dedicated to providing passenger service to distant planets. The principal attraction of industry to this area is, of course, the river. Here, flood control has made desirable water-front industry sites possible. This, coupled with a plentiful supply of clean water, several choices of transportation, ample and economical power, plus abundant natural resources is attracting interest of industries throughout the nation.

A major natural resource in the area is the forest, which accounts for 54 percent of the total land area — some 3.6 million acres. It is composed of seven forest types: yellow pine — hardwoods (45%), upland hardwoods (31%), bottomland hardwoods (11%), yellow pine (6%), cedar-hardwoods (4%), loblolly pine (2%), and blackjack oak — hardwoods (1%). Much of this forest is interspersed by agricultural areas, but concentrated wooded areas do exist mostly in the north and east extremities. The trend is toward an increasing wooded area as reforestation and natural seeding take over abandoned fields which are no longer economically suited to agricultural crops. During the past decade gains of up to 15 percent in wooded area occurred in some of these counties. The average increase for the State was 5 percent.

By volume the three major species categories are as follows:

Species category	Growing stock (million cubic feet)	Sawtimber (million board feet)
Softwood	558	1,611
Soft-textured hardwoods	216	602
Firm-textured hardwoods	1,079	2,909
	1,853	5,122

Farm woodland management by agricultural and forestry agencies has been especially active during the past two decades. Almost 100 "entire ownership management demonstrations" were established on industrial, investment, and farm properties throughout the area. Meeting-type demonstrations attended by timberland owners were held on these woodland demonstrations where examples of good forestry practices and results could be seen. A typical demonstration is that owned by Mr. Robert Reid in Lawrence County, Alabama. Recently, Mr. Reid explained to a group of landowners attending a woodland management meeting on his farm how he had earned $2,370 more by selling wood products delivered to the roadside than by selling on the stump as is customary. Some demonstrations have acquired status through years of accurate record keeping by the owners. An example is the Noble Holland demonstration established 22 years ago in Limestone County. This hardwood demonstration has doubled in volume, increased growth rate from 222 to 397 board feet per acre per year, and provided five harvests of sawlogs during this period. This demonstration approach has served to influence and encourage other landowners to initiate similar forestry practices. Today there are 351 landowners who are known to have fair to excellent management on 560,000 forest acres.

Also contributing to landowner interest in forest management, as well as to the increase in forest area, were the effects of tree planting programs. Some 200,000 acres have been reforested by a large number of landowners.

Many of these early tree planters have already realized a handsome return on their investment and have good prospects for a continued income for years to come. A few examples on a per acre basis of loblolly pine are as follows:

Owner	Acres	Age at 1st thinning years	1st thinning yield		Value remaining stand $	Gross yield @ 45 years			Average annual $ return
			Cords	$		Cds	Mbf	$	
					Per acre				
Pope-Thomas Colbert Co.	18	14	7	34	163	41	37	945	21
Machen, Billy T. Jackson Co.	35	16	6	23	145	34	35	855	19
Chase, Henry H. Madison Co.	4	12	5	15	110	31	32	763	18
Lynn, James W. Morgan Co.	9	19	14	43	71	48	29	719	16

Direct seeding, a relatively new method of reforestation in north Alabama, is becoming increasingly important. The first attempt in this area at establishing a stand of pine trees by broadcasting seed was made in 1957 on U.S. Pipe and Foundry Company's property in Franklin County. This proved to be quite successful. To date, some 10,000 acres have been successfully stocked on several ownerships by this economical and relatively easy method. Currently, the Bear Creek Watershed Association, in cooperation with the State Division of Forestry and TVA, is using a furrow seeder developed by the U.S. Forest Service to speed up the reforestation of all abandoned, open land in the Bear Creek watershed.

When there is an adequate natural seed source and other factors are favorable, Mother Nature can be relied upon to use the direct seeding method to do a reforestation job. In fact, about 50,000 acres of open lands is reverting to a forest condition in north Alabama annually. However, much of this is far from adequately stocked with the number of trees required for maximum wood production.

Fire protection is a major asset to encouraging landowners to venture into the timber growing business. All counties, as is true statewide, now receive organized state protection. The past year's loss was .3 percent, which is about average for north Alabama.

Of course, the thing that makes all of this activity possible and worthwhile is the sale of wood products to industry and their manufacturing into consumer goods.

According to the 1963 State of Alabama Forest Products Severance Tax Report, 147 million board feet of lumber, or 13 percent of total State production came from the Valley counties. In addition to sawmills and planer mills, there are 30 major wood-using industries which process 60 million board feet of wood annually into finished products. They range from hickory handle plants and wooden box plants to furniture and prefabricated house plants. They provide 1,200 full-time jobs and an annual payroll of over $3¼ million. Prospects for new plants and for existing plants to expand are excellent.

For example, considerable interest has been shown by the paper industry in a possible mill site in the Stevenson area. This site offers unusually good advantages in transportation, water supply, and pine pulpwood. The growth of young pine within the procurement area far exceeds the drain – some 900,000 cords annually. In addition, there are thousands of acres of pine plantations that are too young to contain merchantable material but will add substantially to the total volume in the next 10 to 20 years. A major expansion possibility is in Cullman County where a home trailer manufacturing concern plans to add a pine and hardwood plywood plant to their present lumber manufacturing plant.

Following closely behind this expanding market is the wood chip market. Most of the better lumber manufacturing concerns quickly took advantage of the opportunity to increase their income by utilizing their wood waste material to manufacture wood chips. In addition to the market for wood chips by pulp companies, there are metallurgical plants, such as Reynolds Metals Company and Union Carbide Corporation located in the Wilson Dam area, that use large quantities of pine and hardwood chips in the metal refinery process. Wood chip production is increasing about 13 percent annually. During the past year 28 lumber and chipping installations produced 152,000 tons of chips. This is equivalent to the annual growth from 5,700 acres of fully stocked woodlands.

In summary, the forest resources in the 15 counties in extreme north Alabama are becoming more and more important to the economy of the area and the State. Ownership attitude toward proper care of the woodland has improved considerably. Already, the forests are reflecting this stewardship in improved stocking and increased rate of growth. However, there is still a long way to go before near maximum values are realized; but it is obvious that both the people and the forest are headed in that direction.

The Role Of Agriculture In Economic Development

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In recent years, agriculture has received increasing attention, especially concerning its role in total economic development. It has been shown that agriculture can play an even greater role through increased efficiencies and productivity. As recently as the 1950's many development economists looked askance at agriculture. It was argued that industrialization was the dynamic element of the development process, this view being supported with the presumed generalization that the agricultural sector had redundant labor and that the marginal product of labor in agriculture was zero, or at least was less than the institutional wage rate (1). While there still may be some economists who express this viewpoint, there are others who argue for a high priority for agriculture in face of the world food crisis. A third, more predominant, group expresses the view that agriculture has an important role to play, but so do other sectors of the economy. This more recent thinking places emphasis on *balanced* development, with a recognition of the importance of the intersectoral relationships between agriculture and nonagriculture.

Within this framework, we find that agriculture's role in economic growth and development is a vital one. Its main contribution, of course, is to *supply* the *basic food* and *fiber needs* of a country's growing population and economy. However, agriculture's total contributions to economic development go much beyond this fundamental role. As a country grows and develops, industrial and service industries expand, providing complex interrelationships among farms, farm supply firms, and product processing and marketing firms. Moreover, as a society moves to an advanced stage, the complexity of agriculture's contributions increases.

Johnston and Mellor (2) list five categories of agricultural contributions: (1) farm products for domestic consumption, (2) the export of farm products and consequent earnings of foreign exchange, (3) the transfer of manpower to the nonagricultural sector, (4) the flow of money into capital formation, and (5) the increased rural cash income as a market for industrial products. Through these, agriculture is making: (1) product contributions – rising production contributes to a larger gross national product, (2) market contributions – agriculture's purchase of both production and consumption goods helps other sectors to grow and develop, and (3) factor contributions – by transferring resources (labor and capital) to other sectors. According to many authors, these are the three interrelated aspects of economic growth: an increase in total and per capita products, an increase in domestic and international flow of goods and services, and rapid shifts in the structure of an economy.

Agriculture further contributes to economic growth and development, especially during the transitional period, by stimulating growth in processing industries using farm products and in industries producing farm inputs. Agriculture in the advanced stages also supports nonfarm growth through expanded demand for other nonfarm products (3).

In order to better understand the structural changes occurring in a rapidly growing economy, let us look at American agriculture. At the beginning of the 19th century, agriculture was almost the sole means of making a livelihood; 90 percent of the population was engaged in agriculture compared to less than 10 percent today. About 100 years ago, agriculture was responsible for 40 percent of the Nation's GNP compared to 5 percent in 1960. Around 1860, agricultural products made up 80 percent of total U.S. exports compared to about 25 percent in recent years. The dollar volume of farm exports has increased from around $214 million in 1860 to $6.2 billion in 1964.

The United States today is the leading world exporter of agricultural products, strongly influencing international markets for such products as wheat, corn, cotton, tobacco, and soybeans. U.S. exports of farm products averaged just over $4 billion per year in the late 1950's and $5 billion per year in the early 1960's. They have exceeded $6 billion in each of the last two years.

Another factor which has had a pronounced influence on the agricultural industry and on the economy of agricultural areas is the revolution in manpower. Mechanization and automation have resulted in increases in productivity of more than five times in the past century and three times since the mid-thirties. The result has been a drastic reduction in the need for unskilled manual labor.

The application of science and technology in agriculture has resulted in other important changes. Modern agriculture now buys large quantities of materials and services from business and industry. More and more of the processing and marketing functions are becoming specialized and performed by nonfarm firms. The word "agribusiness" is now used to include the agricultural supply firms and the agricultural processing and marketing firms as well as farming. Altogether, agribusiness accounts for about one-fifth of the business activity of the Nation and constitutes the largest individual segment of the American economy.

THE EARLY DEVELOPMENT OF NORTH ALABAMA AGRICULTURE

Now let us take a look at the early history of North Alabama agriculture. Early explorers found Indians living in stockaded villages surrounded by fields and garden patches. While maize was the principal crop, many other crops were raised in sufficient quantities to provide plentiful food supplies. During the period of the American Revolution, several hundred Georgia Tories came into the hill country of Central Alabama and established small farms where they raised corn, cotton, and tobacco. Following this period and prior to 1800, the Tennessee Valley and the Tombigbee region of southwestern Alabama received thousands of settlers from Georgia, the Carolinas, and Virginia. These people, too, were able to support themselves by farming (4).

Following 1800, agricultural history in Alabama is largely concerned with cotton. The level fertile land of northern Alabama, where for years corn, wheat, and cattle had been raised successfully, was found to be excellent cotton country. By 1816, this region had become one vast patchwork of cotton plantations and Madison County alone was producing 10,000 bales of cotton annually.

Early varieties of cotton grown were of the "blackseed" or naked type, with small bolls containing a low percentage of lint. Around 1820, Mexican-type cotton was introduced. The bolls of Mexican cotton were very large and, when ripe, opened wider than those of other varieties. Yields were greater and the spreading of the ripe boll made harvest much easier.

Between 1800 and 1860, cotton production and prices experienced many fluctuations. Average prices varied from 30 cents per pound in 1816 to 9 cents in 1829, and to only about 3 cents in 1845 – a year of an unusually large crop. Land devoted to cotton production grew rapidly, contributing to the erratic cotton prices through overproduction. Much of the increased acreage came about with the settling of the Black Belt area where cotton flourished.

By the time the Black Belt was settled, erosion had become a serious problem in many parts of the state, particularly in the hill country. As early as 1850, many areas, including the Tennessee Valley area, experienced emigration because of the magnitude of eroded and gullied land. During this period, the relative importance of cotton declined in North Alabama. This was due in part to the limited area of rich cotton lands, to the presence of a large number of Tennessee farmers who were inclined to produce cereal crops and livestock, and to the failure of cotton to measure up to the high standard maintained in the southern portion of the state (5).

During the Civil War, cotton production dropped sharply because of the loss of markets and the urgent need for foodstuffs. Following the war, agriculture experienced trying times. Not only had workstock, livestock, machinery, buildings, etc., been destroyed, but many farmers were unable to borrow money to reestablish farming operations. It was during this period that the sharecrop system became widely established. Within this setting, cotton again became the major crop largely because it was the only crop money lenders would use for security.

By the turn of the century immense tracts of once fertile land were badly eroded, resulting in lowered crop yields. The Mexican boll weevil added to the plight of cotton by 1910. All of these factors led to a "revolution" in Alabama agriculture. Many areas such as the Black Belt turned from cotton to grain or pasture, while other areas shifted to fruit and truck farming, livestock and hay and forage crops.

World War I brought increases in farm prices, giving further impetus to grain and livestock farming. After the war, however, prices declined and cotton rose again as the major money crop. Following the depression in 1929, Alabama agriculture entered a period of diversification which is still under way.

RECENT DEVELOPMENT IN NORTH ALABAMA AGRICULTURE

In 1930, the 15 Tennessee Valley counties in North Alabama had a population of slightly more than one-half million people. Farm population accounted for two-thirds of the total population. While total population increased to about 700,000 people in 1960, rural farm population declined to only about 21 percent of the total.

Associated with the decline in rural farm population was a substantial decline in farm numbers and land in farms. The North Alabama area comprises a total land area of 6.6 million acres which is about 20 percent of the total land area of the state. In 1930, land in farms totaled 4.4 million acres or about 67 percent of the total land area. By 1959, land in farms had declined to 3.8 million acres or 58 percent of the total. Land devoted to agriculture actually increased to a peak of nearly 4.9 million acres in 1950; hence, all of the decrease occurred during the past decade.

In 1930, the North Alabama counties had nearly 75,000 farms. Ten years later farm numbers had declined to around 64,000, yet in 1950 they totaled slightly more than 68,000. Since 1950, farm numbers have declined rapidly – to 42,000 in 1959.[1] Thus, farms have been disappearing at an annual rate of 3.8 percent over the past 10 years. For the state of Alabama as a whole, farm numbers declined at about the same annual rate during this period.

While farm numbers and land in farms have declined in recent years, farm size has increased. The average size of farms in North Alabama in 1959 was 99 acres, an increase of 40 acres since 1930. Again, the greatest increase occurred during the past decade when the average size rose by 28 acres per farm.

Most farms in the area, however, are smaller than the size indicated by the average farm. In 1950, 56 percent of all farms contained less than 50 acres of land area and 82 percent contained less than 100 acres, while in 1959, 46 percent of all farms consisted of less than 50 acres and 73 percent had less than 100 acres. During the period 1950-59, a large portion of the decrease in farm numbers occurred in the less-than-100-acre category, while the larger size categories either experienced smaller decreases or actually increased. For example, in 1950 only 624 farms of over 500 acres were reported in the 15 counties, accounting for less than 1 percent of all farms.

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[1] The Census of Agriculture reported 38,341 farms in the area in 1959; however, 3,828 farms were "lost" due to a change in the definition of a farm.

By 1959, 877 farms of this size were reported, making up 2.3 percent of the total number of farms.

Farm size also varied widely in 1959 by types and economic classes. Dairy farms were the largest with 172 acres, while poultry farms were smallest with 76 acres per farm. Farms having annual sales in excess of $5,000 in 1959 averaged 202 acres in size, while those having less than $5,000 sales averaged only 74 acres in size.

Cotton farms were the most predominant type in North Alabama in 1959, making up more than one-half of all farms. General livestock (beef cattle and hogs) were the next most common type, about one-fifth of all farms. Other less important types of farms included poultry (9 percent of all farms), grain farms (6 percent), and general farms (5 percent).

Openland on farms in the area has followed the pattern of total land in farms. In 1930, openland totaled 2.6 million acres but dropped to 2.2 million acres in 1959. This represents a 14-percent decline compared to a 13-percent decline in total farmland area. The proportion of total farmland classed as openland, however, has remained practically constant at slightly less than 60 percent. Cropland harvested also experienced a substantial decline (36 percent) from 1.9 million acres in 1950 to 1.2 million acres in 1959. This decline in harvested cropland is a part of the general shift from crops to livestock in the area.

The two most important crops have also undergone drastic changes. Slightly more than 1 million acres of cotton was harvested in the 15 counties in 1930. By 1959, acreage had dropped to 340,000. However, more recently cotton acreage has increased in the area because of a northward shift in cotton production in the state of Alabama. In the period 1961-63, the acreage was slightly more than 400,000. Corn for grain has experienced almost as great a change – dropping from 919,000 acres in 1940 to 616,000 in 1959 and to 417,000 in 1963.

While corn and cotton have declined in importance in recent years, soybeans (for beans) are rapidly becoming an important crop in the area. In 1950, only 3,900 acres of soybeans were harvested for beans, but by 1959 nearly 23,000 acres were reported and in 1963, 37,000 acres.

Per acre yields of these crops have increased during the period 1930-59. Cotton yields ranged from 245 pounds of lint per acre in 1930 to 516 pounds in 1959. Corn yields averaged less than 16 bushels per acre in 1930, but had increased to 34 bushels in 1959. Yields of soybeans averaged 14 bushels per acre in 1950, 20 bushels in 1959.

Probably the most significant change in North Alabama agriculture during the past 30 years was the dramatic shift from crop production to livestock. In 1930, sales of livestock and livestock products totaled $5.7 million and made up 11 percent of all farm product sales. In 1950, sales amounted to nearly $20 million or 21 percent, and by 1959 livestock sales totaled $83 million and accounted for more than 50 percent of all farm sales.

Most of the increase in sales of livestock during the past decade can be attributed to the tremendous growth in the poultry industry. In 1950, poultry accounted for about 25 percent of all livestock sales, but by 1959 accounted for nearly two-thirds of a much larger total. In dollars, poultry sales rose from $5 million in 1950 to $55 million in 1959. Beef cattle and hog sales more than doubled during the same period, $11 million to nearly $23 million, while dairy product sales rose from $3.3 million to $5.6 million.

Total sales of all farm products in the 15 counties were $165 million in 1959 and represented 40 percent of the total value of all farm product sales for the state of Alabama. You will recall from an earlier statement that the 15 North Alabama counties make up only 20 percent of the total land area of the state. Average sales per farm in 1959 were $4,300 for the 15 counties compared to $3,580 for the state.

Direct farm employment in almost every region of the U.S. has declined in recent years. In 1930, nearly 130,000 persons in North Alabama were employed full time on farms compared to less than 32,000 in 1960. The 1930 figure represented nearly 64 percent of the total labor force, while the 1960 level represented only 13 percent. These figures, however, do not include many part-time and seasonal farm workers nor the indirect agricultural workers. Adding these persons who worked only part time or for various periods during the year, we find that 62,000 people were employed in agriculture for at least some portion of the year.

As mentioned earlier, the term "agribusiness" has come into use in recognition of the complex of economic activity which is created and maintained because of the existence of farming. In addition to the employment of labor and the generation of income directly from farming, agribusiness includes the activity of firms which are dependent upon agricultural production. Some of these firms provide the processing and manufacture of raw materials into finished products while others depend on farms as markets for product inputs and services.

Classifying firms as agribusiness is an extremely difficult process, especially those firms dealing in services, because they may also provide similar services to the general public — not just to farmers. An attempt was made to estimate the number of firms and employment of farm-related businesses in manufacturing. In 1962, there were 230 businesses in the 15 North Alabama counties that could be identified as dealing primarily in the processing or manufacturing of farm products. These firms employed approximately 10,000 persons.

An estimated additional 8,000 to 10,000 persons were employed in businesses providing services to farmers. In total then, agriculture in recent years provided employment, either directly or indirectly, for at least 80,000 persons or 34 percent of the labor force. Certainly fewer people are employed on farms and fewer farms exist; but modern agriculture demands greater productivity and volume which come about through increased capital inputs such as fertilizers and pesticides. These factors, coupled with consumer demands for more services, create additional activity for an economy in the form of employment and income generated in agribusiness industries.

Agribusiness in North Alabama is big in terms of total volume of business as well as employment. While the farm portion of agribusiness totaled $165 million in 1959, it is estimated that the total agribusiness complex represented about one-half billion dollars in products and services. With increased activity in agriculture-oriented firms and increased productivity on farms, the total volume of economic activity generated by agribusiness represented an estimated $0.7 billion in 1964. Figures of this magnitude should dispel the theory that agriculture is a declining industry.

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Recreational Use Of Valley Resources

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In writing this paper, I have drawn freely from several sources. I have consulted information available to each of you and from this material have compiled ideas which I believe will be of interest to you as Alabamians. My viewpoint is that of a native Alabamian who is now working in the Conservation Department as Chief of the Division of Parks, Monuments, and Historical Sites.

In considering recreation facilities and the pursuit of recreation, we must realize that there are varied forms of activities. In some respects the term "outdoor recreation" is often misused. The term includes such things as camping, hunting, fishing, etc. Yet I have heard ardent campers make a sharp distinction between camping and recreation. Similarly, hunting and fishing are sometimes considered apart. The Outdoor Recreation Resources Review Commission Report, in some of its studies, treats sport fishing in a fashion that is something outside the recreation field. Sport fishing is certainly recreation and a highly important and widely followed sport with many facets.

Recreation in the Tennessee Valley is naturally built around water. The large impoundments have given the potential for much pleasure for out-of-state people as well as local residents. My own experiences come vividly to mind when I think of the possibilities of such hydro-electric system lakes. My parents, like most parents, were interested in our having the opportunity of enjoying water sports. I recall my father talking about swimming in the Alabama River near Montgomery when he was young. The current was rather swift and, at best, the swim was a fight against the tide. There were no calm waters. He recounted how one family of three boys drowned in rapid succession, the second and third boys trying to rescue the first brother. In 1929 my father built a house near Mitchell Dam and put a boat on Mitchell Lake, an Alabama impoundment 42 miles from Montgomery. My brothers and sister and I and our friends made many trips to this lake. Our principal sport was aqua-planing. Of course we did some fishing and enjoyed the picnicking and house parties there. There weren't many boats on the lake. Except for a few days a year, we had the lake to ourselves. The picture is considerably changed today in central Alabama, in the Tennessee River Valley, and in fact throughout the Southeast.

The Outdoor Recreation Resources Review Commission Report, published in 1962, included the following:

"Water — Water is a key factor of supply. It is essential for many forms of recreation; and it adds to the enjoyment of many others.

"There are, however, serious problems which will require effort, time, and money to solve. The problems are in three general categories.

"The quality of water is as important as the amount of surface acres, miles of banks, or location. Polluted water in the ocean, a lake, a river, or a reservoir is of little use for recreation. Pollution by human or industrial waste is only one aspect of quality which conditions the available supply. The silt load, the bottom condition, temperature, and aquatic plants also affect the usability of water for recreation.

"The demand for water for many other purposes — domestic use, industries, irrigation, and power generation — is rising. Only with the most careful planning and full recognition of the values of each use will it be possible to achieve an adequate supply of water for recreation.

"While most water bodies are publicly owned, the adjacent land frequently is not. This creates problems of public access which must be solved before much of the total supply of water can be considered as a part of the effective supply of recreation resources.

"The Commission's National Recreation Survey reports that 44 percent of the population prefers water-based recreation activities over any others. Water also enhances recreation on land. Choice camping sites and picnic areas are usually those adjacent to or within sight of a lake or stream, and the touch of variety added by a pond or marsh enriches the pleasures of hiking or nature study.

"Recreation on the water is increasing. This trend is likely to continue as more young people acquire an interest in water sports, new reservoirs are constructed, the boating industry wins new converts, and relatively new forms of water-based recreation, such as skin diving and water skiing, become increasingly popular. In fact, Commission studies indicate that by the year 2000 swimming will be the most popular single outdoor recreation activity — exceeding even driving for pleasure, which now holds first place. The trend will be greatly accelerated if pollution control programs are successful in cleaning up streams, lakes, and seashore areas that are presently off limits for recreation, or are now so unattractive as to preclude many activities.

"As the population grows, interest in water-based resources will reach critical proportions. The problems stemming from this pressure are among the most difficult in the entire outdoor recreation field."

I will cover the numerous facilities of the Conservation Department in the Valley. In addition to these, there are many and varied municipal, county, and private enterprise developments serving the area.

The Game and Fish Division of the Department of Conservation has ten management areas and two refuges in the Tennessee Valley. The management areas are:

Seven Mile Island
Raccoon
Swan Creek
Crow Creek
Wannville (Mud Creek)
Mallard-Fox Creek
Skyline
Black Warrior
Lauderdale
Thomas

The two refuges (where any hunting other than waterfowl is permitted) are:

North Sauty
Crow Creek

These twelve areas comprise 230,334 acres. Public hunting for various game is enjoyed. There are 24 public access areas for launching small craft. These generally consist of a small acreage with a graded access. Pre-cast concrete slabs secured together form a firm launching pad. Paved parking areas nearby permit the boater to leave his car and trailer in ample manuevering room.

The Water Safety Division, the newest division of the Conservation Department, keeps striving "to promote the full use and enjoyment of the waters of Alabama and to assure the safety of persons and property in their use." The total number of craft on Alabama's waters is 120,000. Of this number approximately 30,000 are in the Valley area. The number is on the increase and the demands are increasing for more launching areas, storage and moorings, supplies, aids to navigation, breakwaters, etc. The Water Safety Division concerns itself primarily with enforcement and safety education. The safety education program has been extended to all junior and senior high schools of the state. Informational pamphlets have been published and distributed.

A reduction each year in the number of injuries and fatalities through boating accidents is a major accomplishment.

The law enforcement program is based upon the theory of prevention. Voluntary compliance with the Water Safety Laws and Regulations is our goal through good public relations and informing the boating public as to safe boat handling and the practice of common sense and courtesy on the waters.

Each Water Patrolman receives training in the fields of public relations, first aid, life saving, law enforcement, courtroom procedure, and on-the-job training in boat handling and boating procedure prior to his assignment. Water Patrol Officers are selected for their ability to perform their duties with minimum supervision; gain and maintain respect in their communities; and enter into civic activities. Experience has proved that the delegation of authority to the patrolman instills confidence and motivates initiative. The wisdom of this practice has been amply justified in their intelligent handling of situations under normal and adverse conditions over the past four years.

The Water Safety Division has attempted to create an image in the minds of the boating public whereby the presence of a Water Patrol Officer will be welcomed and he will be accepted as one of the boating fraternity. The sight of a patrol boat and officer must symbolize a measure of protection, safety, and a source of advice and assistance if needed.

The Division of State Parks administers three large parks, two fishing camps, and a public fishing lake in the Valley.

Joe Wheeler State Park is located at the site of Joe Wheeler Dam. The principal development here is in the dam construction village of 30 residences which are now used as vacation cottages. These cottages are occupied primarily by fishermen who enjoy fishing in waters below the dam. Included in this park are recreation areas on the northern side of the lake. For the most part these are undeveloped and have considerable potential.

Monte Sano State Park, on the outskirts of Huntsville, is an exception to the water-based recreation type activity. This park is on Monte Sano Mountain, the Mountain of Health, about 1100 feet above the City of Huntsville. Horseback riding, hiking, and picnicking are the sports enjoyed here. Perhaps at sometime in the future, we will be able to have snow skiing on this mountain.

Little Mountain State Park, near Guntersville, has been developed primarily for tent camping. With a shore line of approximately 50 miles on the largest impoundment in the State, this area affords considerable varied recreation. At present we have 145 tent camp sites and 10 trailer sites. Sufficient grounds exist so that this can be expanded if the demand warrants and funds permit.

Elk River Lodge, located 27 miles east of Florence, is operated under concession contract and has sleeping accommodations for 48 persons. This facility is used by persons from a distance who fish in Wheeler Lake. Many people come from Birmingham to this fishing camp.

Waterloo Fishing Camp, about 20 miles west of Florence, is also operated under concession contract. The State has a small acreage under licence from TVA at this facility.

Madison County Public Fishing Lake is located northeast of Huntsville. It was opened to the public May 30, 1962. This lake has proved to be very popular. With Huntsville's increase in population, it has been found that many persons prefer the relative quiet of these lake waters to those of the river to the south. This lake is one of 20 public fishing lakes operated by the State of Alabama. This public fishing lake program was begun in 1952 and was established primarily to furnish fishing in counties which were otherwise without suitable fishing areas. In 1964, 177,782 fishermen visited these lakes and caught 861,948 fish weighing 233,450 pounds. These lakes, including the one in Madison County, are operated under concession contracts. The lakes are fertilized on a scheduled basis. Careful checks are made to insure that as good a balance as possible prevails for the fishermen's enjoyment.

Within the Valley there are many public access areas completed and five are under construction. These areas generally consist of a semi-portable concrete slab met with an adjacent parking area. With the exception of Wilson Lake, these are fairly well distributed to the population.

The recreational facilities which I have mentioned are the outgrowth of efforts of many persons over a considerable period of time. The money value of the fine facilities would be difficult to estimate. Some management and upkeep of any man-made facility is necessary and constant care is needed.

I have discussed only those facilities with which the Conservation Department is concerned. There are many and varied municipal, county, and private enterprise developments serving the area.

The TVA Power Program And Its Relation To North Alabama

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As you probably know, TVA was created by an Act of Congress on May 18, 1933, as a Federal agency assigned the responsibility of helping the people develop the natural and physical resources of the Tennessee Valley basin. In its far-reaching purposes TVA is concerned with the assistance in development of all of the natural resources of the Valley region — its water, its forests, its lands, and its minerals.

Others will cover various major facets of TVA's activities at this annual meeting of the Academy, and I will confine my brief remarks to the TVA power program and the power activities in north Alabama.

As to the basic power program, it must be remembered that the production and sale of electricity by TVA is simply a part of the broad program of full development of the total resources of the Tennessee Valley. In the TVA Act, Congress made it clear that TVA's low-cost power was to be used as a tool to help the people of this region develop their resources and improve their living conditions.

The Act further provides that electric rates were to be as low as the cost of producing and distributing power would permit. The low rates, it was believed, would encourage a greater use of electricity. In keeping with national policies first developed around the turn of the century, TVA was directed in the distribution of power to give first preference to states, counties, municipalities, cooperatives, and to other nonprofit agencies. Let us see how well these objectives have been met.

In 1933 the utility companies were supplying about 225,000 homes and farms in what is now the TVA power service area. Today there are 156 rural electric cooperatives and municipal electric systems that serve 1,600,000 farms and homes — over seven times as many as in 1933. This expansion has not been due to a rapidly increasing population. It results from bringing service to new consumers in rural areas which the utility companies had passed up as being unprofitable to serve.

We think of power as playing a dual role in regional development. First, it provides a market for the tremendous hydro resources and the extensive coal resources of the area. Secondly, *and more important,* electric energy is a tool to be used to help the people of the area develop their other resources and to improve their living standards.

The TVA Power program is based on the idea that power is not just another commodity to be sold at the highest price the market will bear. Instead, it is treated as an important resource which, if made available in the widest manner at the lowest possible cost, will be an important area economic development factor. To make this idea work, we have developed a very unique partnership between TVA and 156 power distributors.

The power contract between TVA and the distributors of TVA power sets forth our mutual obligations in doing this job together, and it covers the principles to be followed in applying the *low-rate, high-use policy* to regional development. Under the contract both parties agree that electric system revenues will be used for the benefit of the electric consumer and that electric system funds will not be used for other unrelated purposes. I know of no other program similar to this where so much has been accomplished through the use of low-cost electricity as a tool. Yet, in my opinion no place offers greater opportunities in terms of what can be accomplished in the next decade through the continued use of this basic principle.

The power contract divides the responsibilities for the power business between TVA as a wholesale producer and transmitter of power and the local municipal and cooperative systems as the distributors of power. Let's take a brief look at each part.

TVA's job is to produce and deliver power to the distributors who serve an area of about 80,000 square miles, with almost 6 million people. To supply this area TVA now utilizes the power from 48 hydro electric projects; nine are on the main Tennessee River, the others are on tributaries of the Tennessee and Cumberland Rivers. Altogether there is about 4 million kw of hydro capacity.

Four million kw is a lot of power. For instance, the service area had about one-fifth of this power capacity, or 800,000 kw, for all purposes back in 1933. In the early days almost everyone thought we would never use up this area's potential hydro power. How wrong they were. This area soaked up power like a sponge. Because of the use of power by the people and by industry — growth at unprecedented rates — and with the requirements of the national defense plants during World War II — we suddenly found that most of the hydro power potential was developed. We, therefore, turned to the other abundant natural resource of the area — coal. We started building steam electric generating plants in the early 1940's with a plant at Watts Bar, Tennessee. This was a modern plant for its day. It had four 60,000-kw generating units and could produce a kwh with about one pound of coal.

As our loads continued to grow, we continued to add steam plants. Now we have 10 major plants scattered throughout the service area. Last year, roughly three-fourths of our power generation was from steam and one-fourth was from hydro. Of this generation 41 percent was sold to the municipal and cooperative distributors. 20 percent was sold by TVA to a few very large industrial customers. 38 percent was used by the Federal Government in such projects as AEC, AEDC at Tullahoma, the Redstone Arsenal at Huntsville, etc. A small amount was delivered to other power systems under interchange arrangements.

Now what have we done to hold the rates down, confronted with increasing costs and a shift to a larger percentage of our generation from steam power plants? We have simply resorted to larger, more efficient generating units which enable us to spread the dollar cost over more kilowatt hours. Of course, these large units can best be used if you have a large system and one that is growing rapidly. The 200-mw unit was the size we were installing about 10 years ago. Today we have two new 500-mw units in operation at Widows Creek Plant near Stevenson, Alabama. The Paradise Plant in Kentucky has 2 units of 650-mw each in operation, and the new Bull Run Plant under construction will have a 900-mw unit. TVA has contracted with a major manufacturer for the design of a 1130-mw unit to be installed at a yet undesignated location on the system. By increasing the size of the units from 200 to 900 mw, we expect to cut the power plant cost per kw by about 25 percent. Likewise, the operating costs per kwh are expected to be reduced about one-third due to improved design and better over-all operating efficiencies.

With big power generating units you also have to think *big* in terms of coal. Here, we have encouraged the coal producers to mechanize and increase their output so that our coal costs have been gradually going down since 1956. Today our coal costs are less than 18¢ per million Btu or about $4.16 per ton. This compares with an average for the Nation of $6.00 per ton. At the Paradise Plant, TVA contracted with the Peabody Coal Company for a 17-year supply of coal. The company has in operation the largest, most modern mining equipment ever built for this type of operation. The coal will be produced from strip mines, all within 5 miles of the plant, at a cost to TVA of about 12.7¢ per million Btu delivered at the plant, or about $2.80 per ton.

Another area in which we expect to cut costs is through recently agreed upon seasonal exchanges of power with our neighboring utilities serving a number of southwestern states. For example, our loads peak in the winter months, and they are about 3 million kw less in the summer months. The utilities have the reverse situation, so it was to our mutual advantage to enter into an interchange agreement with them which will reduce the idle generating capacity and will permit a more economical operating level for both parties' generating units. This seasonal interchange will begin in 1966 at about 500,000 kw and building up to 1,500,000 kw by 1968. This interchange will be accomplished through two specially designed 500 kv-transmission lines.

From past experience it appears that TVA will need between $150 to $200 million in new capital each year for the next few years. In August of 1959 Congress amended the TVA Act to permit an additional source of capital by the sale of revenue bonds to finance new generating capacity and other power facilities. Some of you may be familiar with this piece of legislation, but let me describe it to you briefly. It permits TVA to sell revenue bonds in the financial market places and to have up to a total of $750 million in bonds outstanding at any one time. Interest on the bonds are subject to Federal taxes. They are not guaranteed by the U.S. Treasury. They are secured only by the revenues of the TVA power system. In connection with this new source of money, the method of repayment of the U.S. Treasury's investment in TVA's power facilities was changed. TVA now makes two kinds of annual payments to the U.S. Treasury. The first is in the nature of a dividend or return on this appropriations investment; it will, in general, be equal to the average cost of money of the Government's outstanding marketable obligations applied to the appropriations invested in the power facilities. Last year this payment was about $40 million. The second kind of annual payment is in reduction of the appropriations investment. This payment started in fiscal year 1961 at $10 million a year, increasing in steps up to $20 million per year by 1971, and continues at this level until $1 billion of the present $1.2 billion appropriations investment has been repaid. Simply stated, the Federal Government, as owner of the system, will receive an annual dividend on its outstanding investment in TVA and will get $1 billion of that investment paid back in about 50 years.

Now let me say just a few words about the distributor's job in this partnership. No matter how good a job TVA does in producing and delivering power to the distributors, it doesn't mean a thing and won't add a bit to the regional development unless the power distributors do an aggressive and efficient job in delivering power to the ultimate consumers. As a matter of fact, they have to do more than just deliver it — they have to teach and encourage the consumers how to use the power to their best advantage.

As a whole, the distributors have done an outstanding job in that their power sales have grown on an average of about 10 to 12 percent per year. Since 1950 the power use per customer has about tripled.

Now what part has north Alabama played in the TVA power program? The TVA power program started in north Alabama. In any number of ways, north Alabama has been a proving ground for TVA.

The first generating facilities that TVA owned were the Wilson Hydro Plant and the Wilson Steam Power Plant. Both had been started during the first World War to provide power for the nitrate munitions plant being erected at the same time here at Muscle

Shoals. Both were transferred to TVA from the Army by the TVA Act.

Muscle Shoals, Alabama, was the first city to buy power from TVA. Today it has the largest average annual residential use of any system I know of in the Nation — about 20,000 kwh. As early as 1934, TVA began to build rural lines in Lauderdale and Colbert Counties. These rural systems were operated by TVA to demonstrate that rural and farm families could be served on a financially sound basis with rates for electricity low enough that the farmer could afford to buy it. Later, these systems were sold to locally owned electric systems.

The generating capacity TVA started with in 1933 was 244,000 kilowatts: 184,000 kilowatts at Wilson Dam and 60,000 at Wilson Steam Plant. Today, the TVA system in north Alabama includes three main river hydro electric plants (Wilson, Wheeler, and Guntersville Dams) with about one million kilowatts of generating capacity, and two modern steam plants (Colbert and Widows Creek) with about 3 million kilowatts of generating capacity in service or nearing completion. With but 244,000 kilowatts of generating capacity in north Alabama in 1933, the same area will soon contain more than 4,000,000 kilowatts of capacity, practically all of it in low-cost hydro and steam power plants.

Seventeen municipal electric systems and eight rural electric cooperatives in Alabama purchase power at wholesale from TVA and resell to nearly a quarter million customers. The 25 locally owned electric systems have invested about $107,000,000 in electric plants. Starting with an investment of about $25,000,000 in Wilson Dam power facilities, the investment by TVA in power facilities located in Alabama now exceeds $600,000,000. And the TVA investment is continuing to grow. The Widows Creek Steam Power Plant in the northeast corner of Alabama is now the *largest steam-electric* generating plant in the United States. The plant has a total rated capacity of 1,675,000 kilowatts.

To accomplish the seasonal interchange arrangement mentioned earlier, work has started on two extra-high voltage (500,000 volts) transmission lines, one of which will extend from the Widows Creek Steam Plant, cross north Alabama — in the vicinities of Huntsville and Decatur — and continue southwest into Mississippi, connecting with the Mississippi Power and Light Company in the vicinity of West Point, Mississippi. This one 500,000-volt line, including substations and connecting lines, is estimated to cost about $44,000,000. These facilities will operate at a higher voltage than any facilities presently in regular operation in the United States. These facilities are unique and their design and construction by TVA required some technological break-throughs.

In conclusion, the total rated capacity of the TVA system is now nearing 15,000,000 kw. The kwh sales during fiscal year 1964 were about 68½ billion. Today north Alabama is one of the most completely electrified areas in the entire nation. Through continued efforts on the part of TVA and the distributors of TVA power, we hope to achieve an even greater goal toward enhancing the economic growth of the region with the continued application of the low-rate, high-use policy for electric power.

Industrial Development And Its Effect On The Growth Patterns Of Urban Centers In Northern Alabama

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Northern Alabama has industrialized at an increasing rate during the last twenty years and this industrialization has led to a changing pattern of growth and size of the urban centers of the region. Table 1 compares the population, number employed, and employment in manufacturing for 1960 with that in 1940 for the state and for the nine northern counties of Alabama. While the northern counties have increased almost 24 percent in population, the number employed has increased 21 percent, and the number employed in man-

TABLE 1. A comparison of population, total employment and number in manufacturing in 1960 and 1940 in Alabama and the nine northern counties.

	Population		Total employment		Number employed in manufacturing	
	1960	1940	1960	1940	1960	1940
Alabama	3,266,740	2,832,961	1,065,877	890,897	282,992	155,345
Colbert	46,506	34,093	14,517	9,024	4,387	1,069
Franklin	21,988	27,552	6,315	6,747	1,645	706
Jackson	36,681	41,802	11,014	11,095	3,484	1,386
Lauderdale	61,622	46,230	19,764	11,716	5,194	1,332
Lawrence	24,501	27,880	6,437	7,048	1,315	140
Limestone	36,513	35,642	11,281	9,460	2,304	261
Madison	117,348	66,317	38,482	17,764	13,637	3,494
Marshall	48,018	42,395	16,042	12,137	4,535	1,215
Morgan	60,454	48,148	19,961	13,508	6,161	2,706
Total for Nine Counties	453,631	370,059	143,813	98,509	42,662	12,309
Amount of Increase	83,672		45,056		30,252	
Percent—Increase	24		21		246	

TABLE 2. Population of urban centers in northern Alabama, 1890-1960.

Cities	1890	1900	1910	1920	1930	1940	1950	1960
Decatur	6,330	7,551	10,583	12,772	15,593	16,604	19,974	29,217
Florence	6,012	6,478	6,689	10,529	11,729	15,043	23,879	31,649
Huntsville	7,995	8,068	7,611	8,018	11,554	13,050	16,437	72,365
Sheffield	2,731	3,333	4,865	6,682	6,221	7,933	10,767	13,491
Counties								
Colbert	20,189	22,341	24,802	31,997	29,860	34,093	39,561	46,506
Lauderdale	23,739	26,559	30,936	39,556	41,130	46,230	54,179	61,622
Colbert-Lauderdale	43,928	48,900	55,738	71,553	70,990	80,323	93,740	108,128
Madison	38,119	43,702	47,041	51,268	64,623	66,317	72,903	117,348
Morgan	24,089	28,820	33,781	40,196	46,176	48,148	52,924	60,454

ufacturing has jumped 246 percent. These figures show that manufacturing is now employing 9.8 percent of the population of the northern counties compared with 8.7 percent of the state as a whole.

The purpose of this paper is to discuss the development and the growth of the urban centers of the region. Three centers appeared early in the history of the region as focal points for settlement. The Muscle Shoals agglomeration or the Tri-Cities began at the west end of the obstruction to navigation on the Tennessee River, Decatur on the east end, and Huntsville at the big springs. Table 2 gives the population of the four largest cities of the area from 1890 to 1960 and the population of Lauderdale-Colbert counties which approximates the Tri-Cities, of Madison County which is co-extensive with the Huntsville Standard Metropolitan Statistical Area of 1960, and of Morgan County for Decatur. With the amount of commuting done at the present time it is difficult to limit urban areas to city boundaries.

Figure 1 depicts the growth of these civil divisions. The tables and graphs show the sharp increase in the population of Huntsville since 1950, the sustained growth of the Tri-Cities since 1930, and the increasing rate of growth for Decatur since 1950. The figures for 1963 are from the Bureau of Business Research and are estimates. They indicate a sharp upturn for all three centers. Map 1 shows the location of cities and counties in northern Alabama.

This paper shall review the development of the northern Alabama area by considering the changing view of the resources of the region, the impact of technology in the use of resources, transportation, communication and administration, and the influence of government as factors in industrialization with resultant growth and redistribution of population. A history of the area will aid the

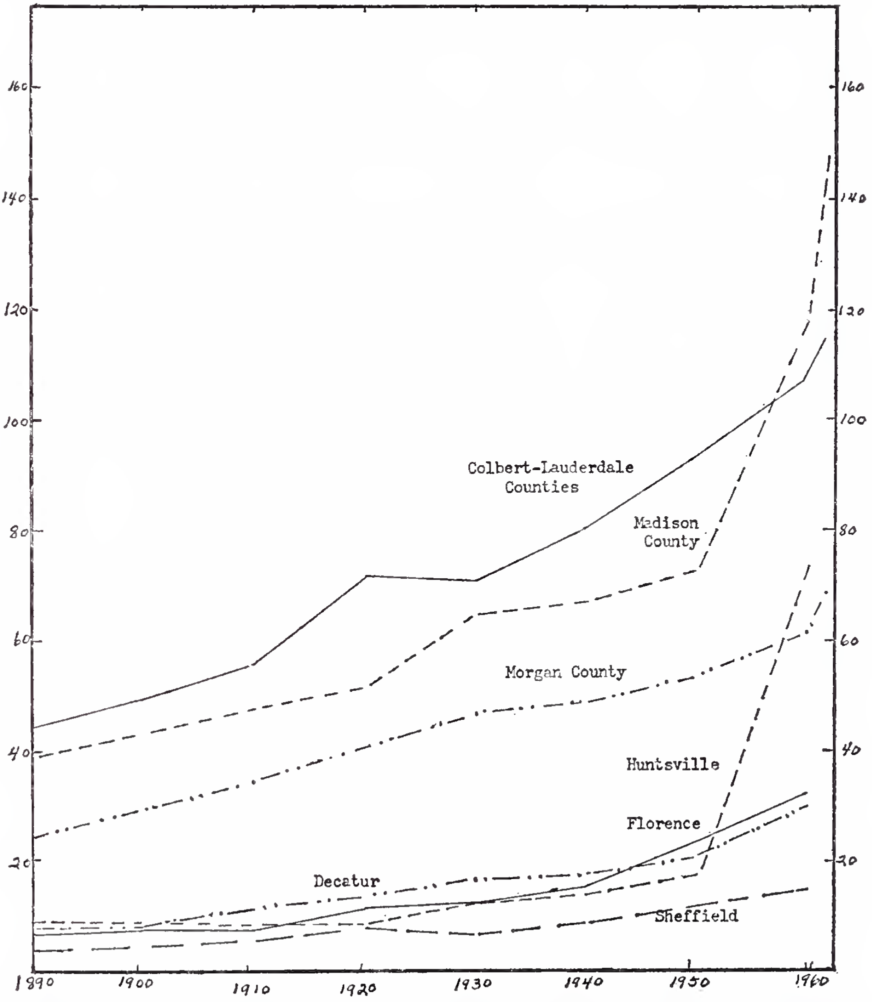


FIGURE 1. The population growth of Colbert-Lauderdale, Madison, Morgan counties, Huntsville, Decatur, Florence and Sheffield, Alabama from 1890 to 1960 expressed in thousands.

analysis of the present situation to see what new factors are influencing growth and development.

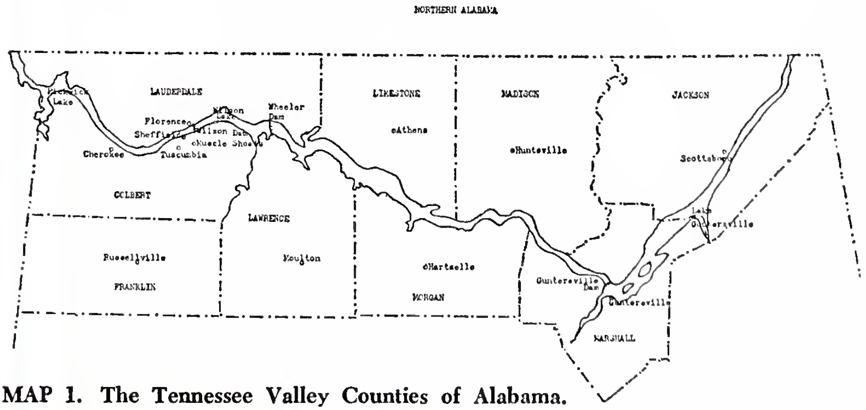
AN APPRAISAL OF THE REGION IN 1935

In 1940 Herman F. Otte published a book entitled *Industrial Opportunity in Northwestern Alabama* which had grown out of research he did in 1935 and 1936. In this study he delineated his region, northwestern Alabama, as seven counties: Colbert, Franklin, Lauderdale, Lawrence, Limestone, Madison and Morgan. Northern

Alabama would also include Marshall and Jackson counties but Otte felt that he wanted to study a region that was not a satellite of a larger center or unduly dominated by a large city. The urban centers considered in this paper all lie within the region studied by Otte and all lie about equidistant from the larger cities, Memphis, Nashville, Chattanooga, and Birmingham of the larger region of south central United States.

The study made by Otte can be considered a benchmark in tracing the development of the industrialization of northwestern Alabama. He gathered his statistics and did his field work in 1935 and 1936 at about the mid-point of the depression era of 1933-1939. Wilson Dam had been turned over to the Tennessee Valley Authority in 1933 and the processing of phosphate fertilizer was started in 1934. Wheeler Dam was completed in 1936 but Pickwick did not become a reality until 1938. The Electro-Metallurgical Company, a subsidiary of Union Carbide, had just acquired a site for a ferroalloys plant but construction was not begun until 1939. The era of free flow of capital into the region, whether government or private, was scarcely at its beginning when this study was made.

Otte traces the history of industrialization in the region. Though a variety of industries started before 1860, the census of that year indicated that less than 6 percent of the population were engaged in manufacturing. Capital was tied up in land and if the opportunity to expand in agriculture was not available in the region new land could be found farther west. By 1880 the textile, flour milling and wood working industries had made a partial recovery from the devastation of the Civil War. The period of 1881 to 1900 was characterized by industrial promotions based on the evident resources in iron, wood and cotton without much knowledge of the amounts of



MAP 1. The Tennessee Valley Counties of Alabama.

these resources available, the capital needed, where markets could be found, or the aid of experienced entrepreneurship.

The years from 1900 to 1935 were years of uncertainty. The cotton textile industry with the largest production in Huntsville increased from 51,000 spindles in 1895 to almost 410,000 spindles in the thirties. The iron industries which in 1900 included six or seven blast furnaces in the Tri-Cities area had gone out of production by 1930. The Tri-Cities' hopes for industry had been excited by the building of Wilson Dam in 1917 and by Henry Ford's bid for the installation in 1921 but nothing had come from either. The TVA Act of 1933 promised river development and low rate power but in 1935 these factors had had little time to make an impact on industry.

After making his analysis of the region Otte made these conclusions:

1. The region was not in a favorable area for the assemblage and processing of large volumes of mineral raw materials. Iron ore was of low quality and the reserves insufficient for the large scale operation of modern industry.

2. The region had an abundance of power with low rates. However the power cost factor was not of primary significance in locating industry except in the electrochemical and electrometallurgical industries.

3. Limestone, asphalt rock and clay were abundant but these minerals support industrialization and are not the basis of industrialization.

4. The industrial water supply of the region was abundant, of good quality, and could be made available at low cost.

5. Cotton was the only agricultural product entering industry directly and a local cotton supply is of minor importance as a factor in the location of a cotton textile industry.

6. Forest resources had played an important role in the region's industrial history, and while the industry had been declining, it could again become an important resource for local industry.

7. The region was not in a favored competitive location when viewed from the standpoint of markets because of lack of population and distance to other markets.

8. The region had transportation facilities by both rail and highway. The Tennessee River with improved navigability and docking facilities might provide advantages in moving heavy materials, but the circuity of its route was a disadvantage.

9. The region had abundant suitable areas for factory sites and for residence space to accommodate a large industrial population. A pattern of industrial distribution had been established which would attract new plants to the existing centers of developments.

10. Labor costs were low, low enough to make cheap labor the strongest magnet attracting industry into the region in recent decades. A labor pool with some experience in factory work and management existed.

11. The community will to industrialize would be a continuing force in establishing manufacturing.

CHANGES FROM 1940 TO 1960

What has happened since this study of the 1930's was made? Could one foresee that a global war would break out in 1939 and bring the world out of the depression? Few were aware of the scientific revolution that was taking place in the chemical industry, industrial physics, optics, aviation, and electronics, or how fast these would grow with demand and capital.

The centers of the region were determined early in the settlement of northern Alabama because of site; Huntsville at the big springs, the Tri-Cities and Decatur at either end of the shoals and these three locations are still the focal points of the area. Tables 3 and 4 show the employment in the three urban areas in 1940, 1950, and 1960. These tables were compiled from the Censuses of Population and therefore show the employment of residents of each area. County figures are used because of commuting.

Employment in agriculture has decreased rapidly during the period and especially in the last decade. Colbert-Lauderdale has lost 64 percent, Madison about 57 percent, and Morgan County almost 66 percent while the labor force has increased almost 28 percent in the Tri-Cities, 71.5 percent in Madison County and 23.6 percent in Morgan County in two decades.

TABLE 3. Economic structure in three urban areas of northwest Alabama in 1940, 1950, 1960

	Colbert-Lauderdale Co.			Madison Co.			Morgan Co.		
	1940	1950	1960	1940	1950	1960	1940	1950	1960
Labor Force	26,800	30,711	34,281	22,498	22,581	38,482	16,144	17,280	19,961
Agriculture	8,261	7,994	2,950	7,742	6,778	3,305	5,410	5,340	1,852
Forestry-fishing	50	139	90	17	37	23	15	97	183
Mining	119	71	59	35	17	33	13	36	39
Construction	1,143	2,684	3,260	501	1,039	2,789	399	1,068	1,888
Manufacturing	2,401	6,453	9,581	3,494	4,499	13,637	2,706	3,274	6,161
Services	8,823	13,370	18,341	5,953	10,211	18,695	5,075	7,465	9,838

TABLE 4. Employment in manufacturing in three urban areas of northwest Alabama in 1940, 1950, and 1960

	Colbert-Lauderdale Co.			Madison Co.			Morgan Co.		
	1940	1950	1960	1940	1950	1960	1940	1950	1960
Manufacturing	2,401	6,453	9,581	3,494	4,499	13,637	2,706	3,274	6,161
Furniture-Wood Products	395	503	312	140	229	188	371	338	331
Primary Metals	251	2,783	4,004	47	18	23	211	488	757
Fabricated Metals	----	224	648	----	157	8,193	----	282	1,431
Machinery-Not Electrical	21	35	51	17	153	552	46	24	279
Electrical Machinery	----	11	230	----	11	577	----	2	105
Motor Vehicles	1	9	54	1	28	4	2	8	124
Transportation Equipment-Not Motor	37	4	28	----	----	1,271	19	66	325
Other Durables	13	94	698	8	82	160	53	118	130
Food	204	307	645	130	190	432	183	366	901
Textiles	651	726	464	2,998	2,620	1,029	1,523	1,257	388
Apparel	8	35	119	7	24	20	1	27	28
Printing and Publishing	95	168	224	85	114	311	37	89	130
Chemical	595	1,266	1,107	8	311	339	195	155	1,107
Other Non-Durables	65	271	981	53	546	538	65	52	125

Manufacturing has increased in all of the centers but in a rather uneven manner. The Tri-Cities area has had the greatest increase, 300 percent in 20 years, but the last decade of the period showed only a 50 percent increase. Huntsville had an overall increase of 290 percent from 1940 to 1960 but the increase took place after 1950. Morgan County had an increase of 128 percent with an 88 percent increase since 1950.

THE INDUSTRIAL CENTERS AT PRESENT

The Tri-Cities

The Tri-Cities or as they are occasionally called, the Quad-Cities, includes Florence in Lauderdale and the three cities, Sheffield, Tuscumbia, and Muscle Shoals in Colbert County. In 1940, though the Tri-Cities was the largest of the three urban centers in the region, it ranked lowest in the number employed in manufacturing. The population of the two counties was over 80,000, that of the cities less than 30,000, and the number employed in manufacturing was only 2,401. Textiles led with 650 workers and the chemical industries employed 595 people. These were the chemical plants of TVA and small fertilizer companies. Furniture and wood products have continued to employ about the same number of workers during the two decades but their position percentage wise has decreased with the increasing labor force. The wagon factory was still operating in Florence in 1940 and employed some 30 men compared with a peak employment of 250 in earlier years.

The decade from 1940 to 1950 brought a rapid increase in population and industry to the Tri-Cities. The population of the two counties increased from 80,000 to almost 94,000. Florence alone showed a gain of 58.7 percent to a total population of 23,879 by 1950. World War II was the stimulant to industry and business in the whole country. Reynolds Metal Company decided in 1940 to locate an aluminum plant south of Wilson Dam on the spur which the Southern Railway had built earlier to accommodate the Union Carbide ferro-alloys subsidiary which was ready to start production. Both plants required large amounts of electricity and obtained the power directly from the Wilson Dam installations. The demand for aluminum and alloys during the war led to expansions and Reynolds set up an aluminum rolling mill as well as the reduction plant. Statistics for 1950 reflect the increase in employment in the Reynolds, Union Carbide and TVA plants which were manufacturing phosphorous for military use, calcium carbide for synthetic rubber, and ammonia nitrates for explosives and fertilizers.

Since 1950 the Tri-Cities has shown an increase and integration of industries. The Reynolds Company has grown and now employs 4,600 with payroll of over $35,000,000. In 1956 the Ford Company built a plant near the Reynolds Reduction Plant enabling use of hot aluminum for castings. In the Tri-Cities, 8 companies are making screens, awnings, siding, etc., from fabricated aluminum.

The Weyerhauser Company located a packing box plant in Florence to serve the needs of plants in the area and completed a third expansion in 1965. The Stylon Company makes ceramic tile and National Floor Products and Robbins make vinyl and rubber tile. Diamond Alkali purchased a surplus government plant in 1954 and by 1956 was producing chemicals. In 1961 the Armour Company completed a fertilizer plant in Cherokee west of the Tri-Cities and near the Colbert Steam Plant.

Decatur

Decatur is located at the east end of that portion of the Tennessee River obstructed by shoals. The first railroad of the South was built from Sheffield to Decatur to bypass the shoals but it was not very successful until the line was completed to Memphis, Chattanooga, and thence to the coast at Charleston. Decatur became the largest city of the area after a railroad was built linking Birmingham and Nashville through Decatur and Athens. At present, Decatur has transport advantages over the other centers because of its location at the junction of the main lines of the Southern and Louisville and Nashville rail lines, the center of radiating highways, and on the Tennessee River.

Statistics for Morgan County (Table 4) show that in 1940 this county had a labor force of 16,144 compared with 26,800 in the Tri-Cities and yet had 2,706 employed in manufacturing, 300 more than the Tri-Cities. A glance at the manufacturing categories shows that more than half were engaged in textiles. Wood products was second and as is typical of the whole areas, employment in wood products has remained fairly constant during the past two decades. The only indication of future development was the comparatively large number employed in foods and related industries.

Statistics for 1950 show little change. Population of the county increased only 1000 and Decatur was now outranked by Florence, the largest of the Tri-Cities. Textile employment was down and food manufacturing had doubled. The Tri-Cities had advantages during the war but the completion of a nine foot channel on the Tennessee River gave Decatur a boost. Barges brought grain from the upper Mississippi and Missouri Rivers and the Alabama Flour Mills, Decatur Grain Cooperatives, and Tennessee Valley Co-op expanded their grain storage facilities. The increase in the livestock production and the broiler industry was associated with cheap transport of feed into the region.

Changes in the basis of industrialization in Decatur came in the fifties. The food and feed industries doubled but the fabricated metals and chemical industries are presently the leaders. The Wolverine Tube Company, the Worthington Air Equipment plant, and the expansion of the Ingalls Shipbuilding Corporation are responsible for much of the increase in metals. Chemstrand came to Decatur in 1952, Minnesota Mining in 1961, and early in 1965 it was announced that Amoco was locating in the city.

Huntsville

In 1940 Madison led the other counties of northern Alabama in the number employed in manufacturing although having a smaller labor force and population than Colbert-Lauderdale counties (Table 3 and Figure 1). The textile industry employed 300 of the 3500 engaged in manufacturing or 86 percent of the total. Huntsville would have been classified as a one industry town even though it was known as the water cress capital of the world.

The census of 1950 showed: (1) no growth in population of the county but an increase of 3400 for Huntsville, (2) that a thousand people who had left the farms were working in the factories. During this decade Huntsville first experienced the boost Federal government can give an economy and the letdown that can result if it withdraws. At the beginning of World War II, the Army Ordnance Corps and the Chemical Corps bought 44,000 acres of land between Huntsville and the Tennessee River and built the Redstone and Huntsville Arsenals. By 1944, 20,000 workers coming from all over the United States were employed. After the war the arsenals were closed and the Army kept only stand-by personnel on hand. The economy was dislocated still further when the largest textile plant began to lay off workers. The decision to convert the arsenals into a research and development center for rockets and guided missiles did not come until 1949 and Dr. Wernher von Braun and his team of experts arrived the next year.

The change that took place in the next decade can be seen in Figure 1 and Tables 3 and 4. An additional 16,000 people in the labor force, an increase of 9,000 in manufacturing, 1,700 in construction and 8,500 in the services indicate a rapid expansion in an economy. Amazing as this may seem for a ten year period, most of the increase came in the latter part of the decade, after the Russians had put Sputnik I into orbit. The decade of the fastest growth has been the last ten years, 1955 to 1965, and present evidence indicates even greater growth in the next ten years. Two statements from a Huntsville-Madison County Chamber of Commerce publication supports this prediction.

"The population as of October, 1964 is 123,648 for Huntsville City and 173,398 for Madison County compared with 72,365 and 117,348 in 1960.

"Madison County has an estimated total employment of 73,040 in mid-August 1964. This was about one-ninth of the total employment in the state of Alabama."

The United States government has three agencies located at Huntsville. The George C. Marshall Space Flight Center is an installation of the National Aeronautics and Space Administration. The other two are the Army Missile Command and the Army Ordnance Guided Missile School with 7,000 students of which 500 are from foreign countries. The total employment is approximately 26,000 and these agencies do only research and development; all production is by contract. Several companies have located in Huntsville and many are branch establishments of large companies and devoted largely to research. The growing population requires more services and the increasing market attracts new industries.

CONCLUSION

From this study of the three largest urban centers of northern Alabama it is evident that their pattern of growth has been uneven. None of the centers has any advantages over the others in natural resources, water supply, power, sites for factories or in nearness to large cities. The labor supply is mobile and neither non-union or cheap labor has been an important factor in the location of industry in any of the centers. All of the cities are interested in attracting more industry and have established industrial parks to aid new industries.

Industry in this region has located and will continue to locate here because of advantages of assembling and distributing. The Southern and L and N rail lines have modernized their equipment and aided new industry. New highways have been built. Decatur and the Tri-Cities are located on the Tennessee River and their docking facilities have benefited industries using bulky raw materials. The Space Agency of Huntsville has built docks for loading the Saturn booster rocket on barges.

Secondary manufacturing with increased value added by manufacturing will become of greater significance. Huntsville has a larger percentage of factory workers in secondary manufacturing and Decatur is showing a rapid increase. The Tri-Cities which lead in the production primary metals and primary chemicals, have a number of new plants fabricating metal goods, making plastics, and paper products.

Federal money has played an influential role in the development of northern Alabama and has directly affected the pattern of growth of the three urban centers. The Tri-Cities benefited first because hydroelectricity from Wilson Dam made possible the production of aluminum and chemicals for explosives and fertilizers during the war. The completion of the nine foot channel has aided the whole region but Decatur has capitalized on the grain shipped in by barge and on ship building. The space program in Huntsville has caused recent growth of that city. Many plants that have located there are branches of large companies and are engaged in research and development. Much of the actual production is done elsewhere but the longer the space program stays in Huntsville, the greater are possibilities for development of factories for production of new products.

Manufacturing is not the only factor of growth. All three urban centers are service centers not only for the factory workers but also for farm business. The number in agriculture has decreased by more than one-half but farm production and income is up. All three centers are distributors for farm machinery, fertilizers, and other supplies, and provide banking facilities.

The rank order of the cities has changed in the past. Huntsville has the lead at present but it has no inherent advantage. Federal money has been the variable and the ability of the urban area to capitalize on this factor will determine the rate of growth.

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Integrating Resource Development—The Bear Creek Watershed Program An Example

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Today we have heard a number of very interesting papers on the development of the basic resources in north Alabama. As concluding speaker, let me emphasize the need for recognizing the interdependence of these activities and the necessity for integrated planning of such activities if maximum benefits are to be achieved.

Consider the development of each of the resources as a building block. Each can stand alone. Each has a value. But put together according to a well conceived plan, they can form a structure of far greater value than that of the individual blocks. They can form the only foundation upon which the maximum economy of an area can be built.

Integrated development is planned development — so planned that each resource, human or natural, is ultimately developed in a manner and to a degree that it will make its maximum net contribution to the total economy and welfare of an area.

The key words here are *planned* and *net.*

In planning, the interrelationships of resources or disciplines must be recognized and brought to bear in all development activities. For example, the relationship of public health or government finance and services to all facets of area development, or the relationship of education or the lack of it to industrial development, or water supply to industrial development, and many others.

In evaluating net contribution, long term benefits of alternate uses of the same basic resources must be estimated and priorities established. Such decisions must be based on the analysis of a comprehensive resource inventory and made, despite constant pressures from the developers of specific resources.

For example, the maximum development of a given area for recreation might not produce the greatest net financial and social return. If, for instance, the entire river front of a particular area were developed for maximum recreation use at the expense of a prime industrial site (of which there are relatively few), the net effect on the economy might be considerably less than if, through planning, the industrial site were reserved. To go a logical step further with this approach, it is probable that the use of this site would be restricted to certain types of industry compatible with the optimum recreational development of the remainder of the area. Recreation gives a little, industry gives a little, and the area receives the greatest net benefit.

Even without integrated planning, most people recognize the gutting of a one-of-a-kind scenic attraction by loggers as an irreparable loss. And many can see the residential development of an outstanding commercial site as a real loss to the community. But, without such planning, very few people can conceive the net loss to the economy, which is possible, from the maximum development of one resource at the expense of another.

TVA's tributary area development program is an attempt to accelerate and integrate the development of the resources in a number of subareas in the Tennessee Valley. These are areas in which special problems inhibit economic growth, where specific opportunities exist for substantial further development of the resource base, and where local groups have organized to turn their own energies and those of their state and local governments, together with TVA's to the economic problems of their immediate areas.

TVA's approach has historically been one of working with and through the people as opposed to doing the job for them. This technique is based on the assumption that only those activities which are understood, appreciated, and are carried out in a spirit of mutual agreement and cooperation will have a truly lasting effect on the people and the area.

There is one thing which TVA's tributary area development program is very definitely not: It is not a program designed to provide emergency relief for Tennessee Valley areas of local depression. It is, rather, an effort to apply to individual tributary areas the total TVA program of integrated development of all resources. This, it is hoped, will not only help to provide jobs and raise incomes in the short run, but will also do a great deal to help build or strengthen the economic bases of these areas and thus alleviate hardship and want on a more permanent basis.

In the time left, let me describe the cooperative Bear Creek Watershed Association-TVA resource development program. This example will illustrate the various organizational and technical devices being used to get the job done.

The Bear Creek Watershed is located in northwest Alabama and northeast Mississippi and includes parts of seven counties. It is roughly 55 miles long and 17 miles wide with a total area of 946 square miles, and has a population of 35,000.

A group of watershed citizens concerned about the continuing loss of population — (especially the outmigration of young people) and persistent water problems — (shortages of municipal water in the upper reaches during drought periods and crop season flooding of farm lands in the lower end) organized the Bear Creek Watershed Association in 1961.

The leadership of the new organization asked TVA for assistance in solving these problems. TVA agreed, providing the Association broaden its objectives to include the comprehensive development of all the area's resources. The Association readily accepted this condition.

The BCWA charter provides that the membership will elect a board of directors with up to 25 members from each of the participating counties, and that the board in turn will elect the association officers. It further provides for eight resource work groups to carry on the Association's area development activities. (The psychology behind the name "work group" is interesting, I think. The leadership felt that anyone agreeing to serve on a work group intended to work.) The officers plus the work group chairmen make up the steering or executive committee, which is the real policy-making body of the organization.

About 10 percent of the total population of the area are members of BCWA. Of the 3,400 members, approximately 2,100 are adults and 1,300 are students. Roughly 150 men and women are actively taking part in the resource development projects carried on by the work groups. Between 600 and 700 members attended one or more bimonthly directors meetings last year, and over 300 attended the last annual meeting.

These meetings are all dinner meetings, and those attending are guests of the host community. To date 14 different communities, many of them unincorporated rural school communities, have asked for the meetings . . . several as many as three times. At first, many of us tended to underrate the value of serving a meal at each meeting, but I'm convinced now that the "socializing" which takes place when folks from all over the watershed eat together and the involvement of local people in preparing and serving these meals have done a great deal to strengthen the Association. The average member has definitely gained a sense of "belonging" and an identity as a citizen of the watershed through this device.

Direct financial support of the Association has come from three sources: membership fees, state appropriation, and private grants. Membership fees are $1.00 a year for adults and 50 cents for students. In addition, there are business and organization memberships at $10 to $25 and lifetime memberships at $100 each. To date there are 19 lifetime members. The Association, as a recognized area development nonprofit organization, received a $5,000 a year appropriation from the State of Alabama for the years 1964 and 1965 and has received several private contributions (by far the largest of which was a $1,000 grant for minerals investigation).

This is the organization with which we work. Now let me describe the steps taken in initiating an integrated development program in the area and, briefly, describe some of the projects undertaken thus far.

The job was broken down into three broad phases — study, decide, and act.

The study phase involved making an inventory to determine what resources we have to work with and analyzing the information for the purpose of assessing potentials in each resource field.

Much of this information was available from various sources such as census data, TVA forest inventories, state geological surveys, etc., and only needed to be assembled. Where this was not the case, inventory schedules or forms were devised and discussed with the appropriate work groups by TVA program division technicians. The work group then collected the needed information.

TVA program divisions summarized the data and drafted an inventory report for each resource. These reports were reviewed and edited by the work groups and then assembled into a single volume for publication by the TVA Office of Tributary Area Development (OTAD).

In reviewing these reports each work group, with the assistance of its TVA and, in some cases, state agency technical advisors, analyzed the information and estimated potentials.

The deciding phase involved making decisions as to how far it is practical to go toward reaching these potentials; how long it should take; and how to go about it. Here again the technical advisors, both TVA and state, met with the work groups to help make these decisions. Together they established long range objectives and set realistic short term goals and prepared a plan of work for the next 12 months. In each case the technicians were prepared to present suggestions as discussion openers. In some cases, the first year, practically no discussion developed and the technicians ended up pretty much laying out the plan of work which was merely adopted by the work group. As the work group members gained experience and confidence through participation, this situation improved and they now take an active part in work planning in most fields.

The primary integrating or coordinating force in this planning process was and is good communication. It almost goes without saying that one group cannot possibly coordinate with the others unless it knows what the others are doing. On the other hand, when all parties concerned are informed, integration is almost automatic. The Steering Committee in the Association and the Office of Tributary Area Development (TAD) in TVA have as one of their most important functions the establishment and maintenance of good channels of communication. The Steering Committee meets quarterly to discuss problems and opportunities of mutual interest and to coordinate plans. Since the OTAD is the primary liaison between

TVA and the Association, a TAD representative attends all work group and Association meetings. By keeping informed as to what is being done and what is being planned in all fields, we are in a position to help the program divisions and the Association coordinate and integrate their various development activities.

In addition, OTAD is constantly in search of situations where the application of technical assistance offers an opportunity to improve the economy and/or the welfare of the area. We seek out this assistance, whether it be within TVA, other agencies, or in private business, and through the appropriate work group, or groups, attempt to bring it to bear on the situation.

The action phase of the program got under way a year and a half or so ago. Some work groups, such as Forestry, have actually had a going program for over two years. Others, such as Water Supply and Use and Public Finance and Services, have found it difficult to develop more than a token program even yet.

In closing, let me briefly describe the more significant projects undertaken by the work groups thus far and point out some of the situations in which some degree of integration was involved. We (and the Association) are the first to admit that the integration achieved thus far is almost superficial, but it is a beginning and the channels of communication necessary to achieve greater coordination are being firmly established.

Minerals:

Arranged for the exploration of a large kaolin deposit near Vina to determine its nature and extent. This eventually involved work group members, the owner, TVA and Geological Survey of Alabama geologists, and a University of Tennessee graduate student. The final report and recommendations have not been issued as yet, but several major companies have indicated an interest in the deposit.

The work group chairman, who is the mining superintendent of an iron ore company, is building a library of all available published and unpublished geological data concerning the area. Anyone may review this material.

The work group sponsored two meetings for the purpose of promoting a geological survey of Tishomingo County by the State. No action has been taken to date. The Business and Industry chairman, who is from Tishomingo County, participated in these meetings and has taken a very active part in trying to promote this project.

The work group has accepted and screened a number of mineral samples submitted by watershed residents and arranged to have the more promising ones analyzed either by the Geological Survey of Alabama or TVA.

Agriculture:

Sponsored a farm management short course.

Established the Northwest Alabama Feeder Pig Association which held a successful sale last fall and has four sales scheduled for this year.

Participated in and promoted a watershed-wide fertilization demonstration program aimed at improving feed grain and forage production.

Business and Industry:

Prepared and mailed 1,700 letters to industrial prospects throughout the United States offering to send them a copy of the resource inventory and inviting their consideration of the watershed for their next expansion.

Identified and mapped industrial sites for each incorporated community in the watershed.

Currently the work group is drafting an industrial development brochure featuring a plentiful supply of high quality male labor and a location central to a rapidly expanding market area.

Forestry:

Promoted the use of five woodland management demonstrations cooperatively established in the watershed by TVA, the state divisions of forestry, and private industry. The Agricultural Work Group has included forestry stops on several farm tours.

Currently contacting all large woodland owners to determine the present status of management and to promote the adoption of improved management practices on these holdings.

Promoted reforestation of open idle and eroding land through: personal contacts, a 4-H-FFA seedling sales contest, a tree salesman project, and currently through the demonstration of mechanical direct seeding techniques. The Agricultural Work Group is cooperating in this project by taking applications for direct seeding demonstrations.

Public Finance and Services:

Nothing to date. Some interest building in promoting tax assessment reforms in one of the seven counties.

Water Supply and Use:

Members of this work group have assisted TVA in collecting information on flood damage and water supply relative to planning a water control system for the watershed. Agricultural Work Group members assisted by collecting flood damage estimates on bottomland farms and estimating the potential for irrigation.

The chairman of this work group was instrumental in obtaining needed road improvements in connection with the Upper Bear Creek Experimental Project. This is a hydrologic investigation aimed at correlating land use with stream flow being conducted by TVA with the cooperation of the United States Forest Service.

At the request of the Bear Creek Watershed Association, TVA has made a study of the need for and feasibility of a multipurpose water control system for the area. TVA has examined the benefits which a system would provide. These include flood relief for some of the most productive agricultural land in the area, increased water supplies for future municipal and industrial use, improved water quality control, new opportunities for water-based recreation, and increased fish and wildlife populations. A plan to provide these benefits has been developed and found feasible, subject to satisfactory arrangements for local participation in the development and use of the project. TVA is engaged in advanced planning and design studies, as well as discussions with BCWA about the nature and extent of the local participation.

Recreation:

This group designed, obtained, and arranged to have erected nine rustic wooden highway signs marking the watershed boundary and carrying the message "Total Resource Development."

The chairman has been very active in promoting the development of the Colbert County Rose Trail Park on the Bear Creek embayment and the Coon Dog Graveyard Park.

He and several members of the work group recently inspected both parks and selected a number of shrubs for outplanting in these areas.

Human Resources:

This work group deals with the fields of public health and education.

In the field of health it has launched an areawide campaign to improve the garbage disposal methods being used. Progress is being made in rural as well as urban communities. Both the Business and Industry and Recreation Work Groups are cooperating in this project, which has a definite relationship to their own activities.

In education the work group is sponsoring a high school dropout counseling project which enlists the help of locally prominent business men and women in combating this serious problem.

That is the story up until now. I'm convinced you'll be hearing more and better things about the Bear Creek area, as BCWA continues to promote the idea that watershed citizens, with technical assistance from their public agencies, can improve the area in which they live through their own efforts . . . that every citizen should demand and personally work for better schools, more recreation facilities, increased job opportunities, etc.

ABSTRACTS

Biology

Biosynthesis, Storage and Release of Intestinal Serotonin in the White Rat

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The objectives of this study were to gain information and clarification as to, (1) the rate or speed of the biosynthesis, (2) fluctuations in the rate of synthesis, (3) the nature of the storage form of the physiological substance, and finally (4) the manner in which physiologically active material is released and in what amounts.

Pharmacological agents choosen for this study were, (1) Alpha Methyl Dopa, purported to be an excellent decarboxylase inhibitor, (2) Marplan, a proven amine oxidase inhibitor and, (3) Serpasil, a reserpinate compound with which we have had success in releasing Serotonin from its "bound" or storage sites. The parameter of physiological activity measured in this study was the gastro-intestinal motility exhibited by duodenal sections removed from experimental animals at stated intervals in the treatment sequence. All duodenal sections were perfused in a constant temperature bath, the motility picked up by a smooth muscle electronic transducer, then amplification of the signal and the resultant activity recorded on a polygraph (physiograph) recorder in time scale. The recordings were quantitated with a polar planimeter.

The results of this study demonstrated the efficiency with which Alpha Methyl Dopa could prevent the decarboxylation of 5-hydroxytryptophan to 5-hydroxytryptamine or serotonin. The lack of production of serotonin was reflected in the markedly decreased gastrointestinal motility. The diminished contractility was accompanied by congestion of fecal material in the large intestine. The storage and release of serotonin was also partially clarified in this investigation. The next and concluding phase of this project will be to validate our present findings with fluorometric analyses of the amounts of serotonin present in the duodenal sections of our experimental animals at stated intervals in the treatment sequence.

Revegetation At The Brierfield Furnaces

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During the late winter of 1865, Wilson's raiders attacked and destroyed the Bibb Furnaces at Brierfield, then the third largest town in Alabama. Attempts to utilize the restored furnaces were abandoned in 1896. One of the abandoned railroad beds, composed of molten slag from the furnaces' interiors, had retained its physical integrity and supported a mixed pine-hardwood forest. This substrate is chemically inert and presents a harsh physical environment for invading plants, yet mature trees, some over 60 years old, have become established. There were fewer but larger trees in this area than the surrounding communities. The railroad bed apparently acted as a dam and trees which develop large root systems were able to tap soil with a much higher water content than the rest of the area. The relatively fewer trees and the paucity of herbaceous vegetation suggest that establishment is the critical phase of revegetation. The entire area was logged extensively just prior to 1964.

Effect Of Crop Rotation On The Population Density Of Soil Fungi As Determined By The Immersion Tube Method

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Estimates of the kinds and numbers of soil fungi associated with crops in a rotation experiment were made over a 3-year period, 1958-1961. Plants included in the rotation were oats, wheat, and caley peas in various cropping sequences on a Sumter clay soil in southwest Alabama. Monthly determinations of soil fungal populations in each plot were made by the immersion tube technique as modified and previously described by the junior author. Perforated tubes containing potato dextrose agar were inserted into the rhizosphere of several plants within a plot. After 24 hours, tubes were recovered and held at room temperature until fungal growth sufficient for identification occurred. Soil temperatures at the time of tube collection were also recorded.

Of the 3,749 isolates obtained from all plots over the 3-year period, species of *Fusarium*, *Rhizopus*, *Rhizoctonia*, *Helminthosporium*, *Cladosporium*, *Diplodia*, *Alternaria*, and *Aspergillus* predominated. Of these, *Fusarium* and *Rhizopus* spp. accounted for 42 and 26 per cent of all isolates, respectively. Isolation frequency of *Fu-*

sarium spp. was highest during periods when soil temperatures ranged between 11 and 20 C. Greatest numbers of *Rhizopus* isolates were obtained at relatively higher soil temperatures in the range of 20 to 30 C.

Kinds and numbers of fungi associated with the various crops were generally similar. Cropping sequence had little effect on some fungi commonly regarded as harmless saprophytes. However, some effects on population trends of certain pathogenic fungi were noted. *Helminthosporium victoriae*, an oat pathogen, was usually isolated in much reduced numbers from plots in which continuous oat cropping was interrupted by a planting of wheat or caley peas. Similarly, the isolation frequencies of *H. sativum* and *Diplodia* spp., pathogens associated with wheat and caley peas, respectively, were lowered when non-host plantings were introduced into a continuous host sequence.

Controlled Environment Chambers For Avian Research—Some New Concepts

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Two psychrometric chambers of an improved design have been constructed for avian environmental studies at the Agricultural Experiment Station, Auburn University. These chambers utilize cavity walls and a total exhaust ventilation system to separately control interior panel surfaces and air temperatures. This system also permits air temperature control with low volume air exchange and without recirculating chamber air through a heat exchanger.

Heat gains and losses from the chamber surfaces are controlled by varying the temperature of the air within the cavity walls. This air is completely separate from the chamber and serves only as a heat transfer medium. The cavity wall design allows the mean radiant temperatures of the ceilings, walls, and floor to be held at a constant uniform level independent of the interior air temperature.

Air temperature and moisture within the chamber is maintained by means of a total exhaust air ventilation system. Outside air is preconditioned by being cooled and dried. The air is then reheated and humidified to provide the desired air temperature and moisture level within the chamber. Hot water provides the source of energy to reheat the incoming air and steam provides the source of air moisture. Both are regulated with proportioning type pneumatic valves connected to temperature and humidity controls located in the exhaust air duct.

Each of the two prototype chambers measures 8 × 10 feet and has an 8-foot ceiling. All interior surfaces are constructed of smooth sheet metal finished with a glossy white enameled surface. These sealed, windowless chambers may be used for studies involving the following environmental parameters: temperature, humidity, intensity and wave length of light, air composition, atmospheric dust, ventilation rate, and volume of air exchanged. These parameters may be controlled, one or more at a time, to study the interactions of environmental factors. It is also possible to study the effects of rate of change of one or more of these environmental parameters upon avian physiology.

The two prototype chambers, which were relatively inexpensive to construct and operate, have been successfully functioning for 2½ years. Valuable data relating to the effects of environmental factors upon atmospheric dust have been obtained and reported. A new Avian Environmental Physiology and Bioengineering Laboratory will be constructed at Auburn this year. It will contain 16 similar chambers together with backup facilities. It will be the largest and one of the most modern facilities of its kind in the world.

The Possibilities Of Telemetry In Biological Research

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The use of radiotelemetry to obtain information from unrestrained animals is highly desirable. Biotelemetry has developed rapidly with the aid of space biology and computer and military electronics. It is now being applied widely to animal ecology, migration studies, marine biology, determination of ovulation in women, hospital care of patients, gastrointestinal, and neurophysiology.

Radiotelemetry is an invaluable tool for the physiologist who hitherto has had to garner data from restrained or caged animals. Many unsolved problems still exist for those who wish to use miniaturized telemetry in their experiments. Such equipment is not at present available. Indeed, the possibilities of obtaining off-the-shelf biotelemetering units are questionable. It will probably be necessary for each biologist to develop from available components his own equipment in cooperation with electronics engineers.

The basic components of a biotelemetry system include a unit for sensing and transmitting data and a unit for receiving the signals, organizing them, and recording them in digital or analog form on tape or by means of standard recording equipment. With the development of more sophisticated equipment, it is hoped to monitor simultaneously several physiological parameters from one animal.

With physiological studies the multichannel system is being developed to transmit up to 30 feet. Ecological studies require much greater distances, but usually a simple homing signal is all that is needed to locate the animal. With transmission over such distances, wave length availability must be investigated. The experimental physiologist is likely to be more concerned with interference from outside rather than his signals interfering with other transmissions.

Miniaturization needed to adapt telemetry for use with animals as small as a quail will give rise to several problems. The length of battery life because of size limitations immediately becomes apparent. The possibilities of using muscle energy for transmission are currently under review. The question of whether to implant or place the battery and transmitting unit on the surface of the animal gives rise to questions involving tissue compatability and homeostasis.

Specifications have been established for building equipment sufficiently small to use with Coturnix quail for monitoring EKG, ECG, respiration and heart rates, blood pressure, body temperature, ovulation, and intestinal and muscle pH. Discrimination would be necessary in such a multichannel system. Many receivers now available could be used in this system, but difficulties are foreseen in recording some of the high speed parameters encountered in avian physiology. Sensors and transducers for obtaining the original physiological data are relatively advanced in development since they already have been used to some extent in space biology and experimental physiology with restrained animals. With greater dependence upon such sophisticated equipment, the biologist will require better trained technicians and adequate facilities for speedy maintenance and repair.

Effect Of Atrazine On *Sclerotium Rolfsii* And *Trichoderma Viride*

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Increased use of herbicides has raised questions regarding effects of these chemicals on soil microorganisms, including soil-inhabiting phytopathogens. The common soil-inhabiting saprophytic fungus, *Trichoderma viride,* is a known inhibitor of *Sclerotium rolfsii,* a fungus that causes a serious root disease of many southern crop plants. Research was initiated to study effects of several new herbicides on populations and interactions of potential biological control agents and plant pathogens. First consideration was given to the preemergence herbicide, atrazine (2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine). In flask shake-culture of atrazine-treated soil suspensions, the density of fungi that were inhibitory to S. *rolfsii* in standard assay tests reached a peak (60% of isolates tested) at 20 ppm atrazine and then declined at higher concentrations. Ninety-five per cent of these fungal isolates were *T. viride.* Concentrations of atrazine above 10 ppm in a culture medium inhibited linear growth of S. *rolfsii* in pure culture. In presence of *Trichoderma,* inhibition of the pathogen is greatly increased, but further inhibition attributable to atrazine was negligible. Sclerotium production on atrazine agar decreased sharply with increased atrazine both in the absence and presence of *Trichoderma.* Sporulation by *Trichoderma* in previously sterilized soil decreased with high concentrations of herbicide in the soil. Sclerotium production by S. *rolfsii* alone in herbicide-treated soil was reduced slightly at 2 ppm atrazine but not greatly influenced further by increased concentrations. In presence of *Trichoderma,* sclerotium production was greatly reduced in no-atrazine checks, then production increased with increased atrazine. Similarly, percentage germination of sclerotia produced in atrazine-treated soil containing S. *rolfsii* alone decreased with increased atrazine concentration. Germination of sclerotia from S. *rolfsii* + T. *viride* culture in soil was very low among sclerotia from no-atrazine soil, but percentage germination greatly increased among sclerotia formed in atrazine-treated soil. These preliminary results indicate that atrazine may directly affect the activities of S. *rolfsii* or T. *viride,* and may influence the complex interactions between the two fungi.

Chemistry

Preliminary Study Of Effluent Tritium From Electron Capture Detectors Used In Gas Chromatography

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The effluent from the electron capture (E.C.) detector was collected in a cold-finger containing 60 ml of liquid scintillator solution. Counting was performed in a Model 3302 Packard Tricarb fast coincidence liquid scintillation counter. Preliminary data collected is discussed. The E.C. detector surface contamination was monitored using 2″ D. hard milled paper. Quantitative data and levels detected are presented. This work is supported by the U.S. Public Health Service Grant Number DRH-46-65.

Identification Of The Fe(III) • Di-Sec.-Butyl Phenylphosphonate Complex

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When a 7 *M.* HCl solution containing 12 mg. of Fe(III) is treated with 5% w/v di-sec. butyl phenylphosphonate in kerosene, a yellow layer separates between the aqueous and organic layers. It is believed that this is essentially pure Fe(III) di-sec.-butyl phenylphosphonate complex.

An empirical relation of Fe(III) to the total weight of material has been determined, and the molecular weight has been determined by classical methods. Spectral data in the visible, ultraviolet, and infrared regions has been collected for the complex, the complexing agent, and the solvent. NSF-URP Grant #GE-6416, financial sponsor of this research; W. R. Mountcastle, Jr., director.

A Spectrophotometric Study Of The Niobium(V) m-Cresotic Acid Coordination Complex

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The soluble niobium(V) species present in a concentrated sulfuric acid solution, when added to a solution of m-cresotic acid and the pH adjusted to a value of 13.2, forms a complex species that absorbs at 318 mμ. The formation constant, k_1, for the species which formed in solution was calculated from spectrophotometric data.

Preparation Of Oxamide From Formamide

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Formamide, which is readily prepared from ammonia and carbon monoxide, was considered as a starting material in studies of methods for the preparation of oxamide. Attempts were made to prepare oxamide by oxidative coupling of formamide. Ordinary oxidizing agents, dehydrogenation catalysts, and exposure to ultraviolet light did not give the desired reaction. Simple electrolysis of formamide yielded only cyanuric acid. Glow-discharge electrolysis and treatment with Fenton's reagent — a mixture of ferrous sulfate and hydrogen peroxide — each converted formamide to oxamide, but inefficiently. Each treatment generates hydroxyl free radicals which appear essential to the reaction. The method is too costly for the production of fertilizer.

Geology And Anthropology

Consistent Geologic Map Contacts And Isopleth Patterns Of The Upper Mississippian In The Beans Creek Area, Tennessee

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The stratigraphic section of Upper Mississippian strata in the Beans Creek area (approximately 80 square miles, located in the southern portions of Franklin and Lincoln Counties, Tennessee, and the extreme northern portions of Madison and Jackson Counties, Alabama) consists of the Monteagle Limestone, a fine- to medium-grained oolitic and fossil-fragmental limestone, which is divided into two subdivisions by the horizon of the "Lost River" chert; the Bangor Limestone and Hartselle Formation, Undifferentiated, a fine- to coarse-grained dark brownish-gray calcarenite; and the Pennington Formation, composed of red and green variegated shales, dolomite, and Bangor-type limestone.

A technique involving graphic subtraction of isopach patterns was used in preparing the structural contour maps. These structure maps were used as a guide in drawing contacts on the geologic map between observation points. The error that may be introduced to the geologic map is mainly due to the basic assumption that the isopach maps are correct. However, this technique ensures consistency between isopach, structure, and geologic maps.

Geology Of The Waterloo Tripoli District

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Extensive deposits of tripoli occur near Waterloo, Lauderdale County, Alabama, and in adjacent areas in Colbert County, Alabama; Tishomingo County, Mississippi; and in Harding and Wayne Counties, Tennessee. The tripoli deposits are in the upper part of

the Fort Payne Chert and in the basal beds of the Warsaw Limestone, both of Mississippian age. Some of the deposits are overlain by chert gravels of the Tuscaloosa Group of Late Cretaceous age, but other deposits are separated from the Tuscaloosa by chert beds.

The tripoli occurs as tabular or lenticular deposits replacing the chert and contains some chert fragments. The tripoli is composed of white to very light gray silica in the clay size range. The thickness of the deposits ranges from a fraction of an inch to more than 60 feet.

Economic Geology Of The Moon, A Pessimistic View

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For hundreds of years man has dreamed of exploring earth's nearest neighbor, the moon. Only very recently has he dared to begin to translate his dreams into plans. It now appears that within a few years the first man will set foot upon the moon. A carefully planned lunar exploration program should benefit many, or probably all branches of science. I should like to consider some of the implications for geology of such a program.

In the conventional sense, economic geology deals with the exploration for and understanding of economic mineral deposits. As implied in the title, I believe that there are reasons for pessimism when we consider the economic geology of the moon, or perhaps we should say economic selenology, in this restricted sense.

A variety of factors must be considered in the evaluation of a mineral deposit. Among them are factors pertaining to the inherent value of the deposit, including concentration and size, and factors pertaining to the accessibility and recoverability of the valuable materials.

Considering first the factors pertaining to accessibility, at least some degree of pessimism seems to be indicated. Certainly the trip to the mining site presents problems as would transportation of materials back to earth. It is possible, however, that material recovered on the moon will eventually be for *use* on the moon. The savings in earth to moon transportation could be tremendous. As for problems of recoverability, I feel confident that in retrospect they will appear little or no worse than many which have been faced on earth.

My pessimism refers primarily, then, not to accessibility and recoverability factors, but to factors pertaining to the inherent value of deposits.

Two major theories, the volcanic and impact, exist as to the origin of surficial features and materials of the moon. If all or part of the moon's surface is covered with meteoritic material, iron and nickel may be in plentiful supply, but based upon compositions of meteorites found on earth, other metals may be in short supply. If all or part of the lunar surface is covered with volcanic material, and the albedo seems consistent with, for example, basaltic material, the metal supply picture may be quite different. Copper, nickel and other base metals are found associated with terrestrial rocks of basaltic composition, but might not be associated with lunar basalts. The terrestrial basalts with which these metals are associated are located in areas of continental crust. Such large outpourings of basalts as the Hawaiian Islands may not be strongly metallized.

In fact, most of the known mineral deposits in the world are associated with areas of continental crust. I hasten to note that this is in part a function of ease of exploration! It is my contention, however, that there is a genetic connection between continental crust and many mineral deposits. The intense geochemical differentiation and concentration associated with the formation of continental crust may well be essential to the formation of economic mineral deposits.

Regardless of whether we accept a simple picture of continental accretion or a more sophisticated model for the development of continental crust, it seems evident that the sedimentary cycle plays an essential part. Therefore, the suggestion is made that the moon, having no sedimentary cycle, has no "continental crust." Perhaps we had better expect lunar mineral deposits to be small or even non-existent.

All this is not intended to indicate that I am uniformly pessimistic about the value to the geologist of lunar exploration. From a less restricted viewpoint we should be able to perceive many benefits to be derived. Two or three examples will illustrate.

One current theory holds that the moon's developmental history paralleled that of the earth. The moon, then, is in effect a scale model of the earth. Any model, such as for the chemical and physical evolution of the earth might be appropriately scaled down and predictions made as to the physical characteristics, internal structure and the like of the moon. Carefully planned lunar exploration may or may not establish correlation between prediction and discovery. Our developmental model, or the basic theory, may be supported or denied.

A great deal of the sedimentation which takes place here on earth is concentrated in elongate crustal depressions of uncertain origin called geosynclines. It is generally accepted that sediment loading may aid in their growth but almost certainly cannot initiate them. Some sort of negative movement of a segment of the earth's crust must be the initial step. A number of theories, none of which finds universal acceptance, have been advanced to explain the beginning of downwarping. Perhaps incipient lunar geosynclines, unobscured by the inevitable sedimentation of earth, exist to furnish a much-needed clue to the mechanics of geosyncline formation.

Finally, I should suggest that we might test one of my own assumptions, that the sedimentary cycle is essential to the formation of a continental crust. If the moon has any continental crust, my assumption is destroyed; unless I can show the existence of erosion and deposition on the arid and airless moon!

If we can consider the acquisition of knowledge an economic good then my title is certainly misleading. Even as regards economic geology in the conventional sense, there is plenty of room for optimism. In the first place, we cannot evaluate the mineral deposits of the moon until we get there. In the second place, the moon may present us with a scale model of the earth, different yet similar, where we can test our hypotheses on terrestrial processes, including those on ore formation.

In conclusion I should like to point out that the value of a lunar exploration program to geology will be determined by geologists. We must anticipate what can be learned and be prepared to learn it. An important decision to be made in connection with any research project is what questions to ask. Now is the time to formulate the questions and to devise the means by which we may gather the data which may serve to answer them.

Chromium Enrichment In Hydrated Iron Oxide Sediments, Southeastern Alabama[1]

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Determinations of chromium content by colorimetric methods indicate that chromium concentrations in some deposits and specimens of southeastern Alabama brown iron ore exceeds concentrations expected in limonite or goethite, and exceeds the crustal average of 200 ppm. Chromium ranges from 200 to 2,000 ppm in samples collected from four localities in Butler County, and from 200 to 3,200 ppm in samples from Barbour, Dale, Coffee, Covington, Crenshaw, Geneva and Pike Counties.

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[1] Publication authorized by the State Geologist.

The exact mode of occurrence and mechanisms of concentration of the chromium in the hydrated iron oxides are not known. Chromium in the form of the chromate ion $(CrO_4)^{2-}$ probably was derived from weathering of overlying and adjacent sediments of "normal" concentration and may have been concentrated by: (1) the mutual attraction of chromium compounds of net negative charge, and positively charged colloidal particles of hydrated iron oxide; and (2) the immobilization of chromium by the formation of an insoluble ferric chromate. Some chromium may be present in the sediments as adsorbed ions.

A Study Of Flint And Ceramic Relationships At Four Selected Alabama Aboriginal Sites

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The purpose of this study was to study possible associations between certain pottery types and projectile point types at the Flint River Site, in Madison County, Alabama, the Stanfield-Worley Bluff Shelter and the Little Bear Creek Site, both in Colbert County, Alabama, and the Asbury Rock House in Marshall County, Alabama. These sites were selected because of (a) the adequacy of recorded data from them for correlation purposes, (b) their proximity to each other, (c) the well-defined stratigraphy, and (d) the previous reclassification of the flint projectile point types by James W. Cambron which eliminated inconsistencies in the assignment of type names.

Projectile point types used in the study were those established by James W. Cambron (1963). Ceramic types were based on those used by Marion D. Heimlich (1952) with certain modifications by William Sears and James B. Griffin (1950).

The following procedures were employed in this study: (1) an analysis of ceramic and projectile point distributions by levels for each of the selected sites; (2) an analysis of ceramic and projectile point distributions by zone for each of the selected sites; (3) a comparative analysis of ceramic and projectile point distributions by levels and zones for each site. Other well documented sites were used as a check for consistencies.

A preliminary study of the published reports suggested that there existed three major groups of projectile point types, each group being dominant in a particular cultural horizon or phase. The first of these groups consists of the types associated with Early Woodland ceramic forms. Projectile point types of this group consist of types designated by Cambron as Flint Creek, Little Bear Creek, Mulberry Creek, Cotaco Creek, Mud Creek, Flint River Spike, and Bradley Spike. All of these forms with the exception of Bradley Spike and Flint River Spike occurred with the earliest ceramic forms which were tempered with plant fibers. The above projectile point types, including Flint River Spike and Bradley Spike, also occurred with the slightly later sand tempered wares.

The second group of associations consists of the projectile point types identified as Swan Lake, Greeneville, Camp Creek, Nolichucky, Candy Creek, Gary Stemmed, Flint River Spike, Bradley Spike, Mountain Fork Stemmed, Coosa, and Jacks Reef Corner Notched. These were the dominant types which occurred in the same stratigraphic levels as the limestone tempered wares of the Middle Woodland phase. The Swan Lake point also continued in use after the introduction of a slightly later ceramic form which was tempered with particles of crushed burned clay. This clay-grit tempered pottery has been identified as belonging to the Late Woodland-Early Mississippian phase. However, there seems to have been an appearance of a new projectile point type which was primarily associated with the clay tempered ceramics. This point consisted of a small triangular form classified as Madison. Another closely related triangular form has been identified as Hamilton.

That the Madison, Hamilton, and Swan Lake point types were contemporaneous with the clay-grit tempered wares is suggested by their dominance in the upper two levels in the four sites studied.

The final group of associations includes the small triangular point types previously described and the shell tempered wares of the Mississippian horizon. It is generally agreed that the small triangular points are usually encountered on most Mississippian sites throughout the Southeast. Stratigraphic placement of these at the four sites studied supports this fact.

One other projectile point type that seems to have made its appearance during the latter phase of the Mississippian has been identified as Guntersville Lanceolate. The survival of this point into Historic times is suggested by association with Historic burials.

The overall picture concerning these associations is extremely complicated and much overlapping of both traits from one cultural horizon or phase must have occurred. The sequence is to some degree fragmentary since some pottery and projectile point types were present at some sites and absent at others.

Even though it was not possible to establish a relationship between a single pottery and projectile point type, it was demonstrated that certain groups of projectile points were prevalent at the same time as certain pottery groups.

It is anticipated that these pottery and projectile point associations will serve as an aid in establishing a consistency in certain aspects of the occurrence of technological change and also to make possible certain predictions concerning these changes in the Tennessee Valley.

The establishment of these associations will also serve as an aid in the verification of Tennessee Valley pottery sequences and as a partial indicator of cultural change and continuity.

Physics And Mathematics

Determination Of Density In A Cavitating Flow Using Bremsstrahlung Radiation

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Preliminary studies utilizing an energetic beta source for the determination of void fraction in a cavitating medium is discussed. Conventional gamma pulse height spectrometry is used to measure, through a collimator, the Bremsstrahlung radiation. A series of equations and derivations involving the cavitation phenomenon in a venturi are presented.

A closed water loop is used for the study of the axisymmetric cavitating flow. This work is supported by the U.S. Public Health Service Grant Number 1T1RH61-01(64).

Techniques Of Analysis Utilizing The Sliding Pulse Analyzer System

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The sliding pulse analyzer in addition to producing quality spectra has many other applications previously not available in conventional single channel pulse height analysis. The recently introduced method allows specific applications such as alpha-beta counting, G-M tube characteristic plotting, et al. System stability is illustrated

and discussed. Examples are (a) Repeated scan of a sample spectrum and determination of that spectrum at a prescribed time interval. (b) Scanning spectrum in one direction, then repeating same scan in opposite direction (higher energy to lower energy and vice versa). (c) Setting baseline on pre-determined length of time and plotting signal over a prescribed length of time. Spectral scans in the lower energy (Kev) range is discussed using the Sliding Pulse Analysis System. Programming the two storage units allows alpha and beta emmission of the nuclide to be counted simultaneously and with discrimination. This work is supported by the U.S. Public Health Service Grant Number 1T1RH61-01(64).

Sliding Pulse Versus Conventional Pulse Height Analyzers

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The basic methods of conventional single channel pulse height analysis is discussed. The recently introduced SLIDING-PULSE ANALYSIS SYSTEM is included. This method holds spectral sensitivity constant by fixing the window base and sliding the pulses to the window by linearly changing the high voltage on the photomultiplier tube. A quasi-logarithmic response is exhibited. Advantages of this approach are discussed. A spectral range ratio of 100 or even 1,000 to 1 can be noted. This work is supported by the U.S. Public Health Service Grant Number 1T1RH61-01(64).

Social Sciences

The Physiocrats And Their Contribution To Distribution Economics

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The first scientific school of economics developed in France about the middle of the eighteenth century as a result of intolerable political and economic conditions caused by many years of war and extravagance. Physiocracy lasted for about twenty years — 1756 to 1778.

The founder of the Physiocratic school was Francois Quesnay. His whole plan was built upon a concept of natural order which could be applied to the relation of state to trade and industry. Production and distribution of goods should be in accord with the fixed laws of nature and not interfered with by government restrictions.

The Physiocrats made land the most important agent of production. Labor, when applied to land, was capable of producing a surplus or "net product." Basically, it was held that all exchange was unproductive, for it was but an exchange of equal values. The circulation of wealth was conceived in the *Tableau Economique.*

Despite interest in securing a good price for agricultural products, the Physiocrats showed little interest in a value concept. Rent was regarded as a "providential surplus." Capital and interest did not receive any significant treatment by the school.

The indirect influence of the Physiocrats is perhaps more significant than any direct influence on the field of economics. The Physiocrats showed the interdependence of all groups in an economic society. The comparison of the flow of wealth within the economic system to the circulation of blood in the anatomy showed a dynamic concept of society. The Physiocrats may be credited with the systematization of economic ideas, the development of the concept of free competition, and the recognition of the complete interdependence of all elements in an economy.

Prototype For A Nation: The Establishment Of The Alabama Department Of Archives And History In 1901

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The original concept of a state department of archives and history was developed in the mind of an Alabamian, Thomas McAdory Owen, and the prototype created under his leadership by the Alabama legislature in 1901 was subsequently copied by many other states. Owen's accomplishment did not come easily but was the work of a lifetime. After practicing law in Bessemer for a few years, he became a government clerk in Washington in 1894. He carried with him to the nation's capital an ardent interest in collecting historical materials on his own state. There he had access to the Library of Congress and made the acquaintence of kindred spirits from all over the United States. Returning to Alabama to practice law, he gave most of his attention to reviving the state historical society. He became chairman, without pay, of the Alabama Historical Commission and in that capacity studied thoroughly historical societies and how they functioned in other states. He found them inadequate for securing the preservation of public records. To solve the problem he recommended a state department of archives and history, which Alabama established in 1901, with Owen as director. Under his leadership this became an effective institution for preserving public and private records of his state and its people, and provided a model subsequently followed by numerous other states.

The DUD In Livingston, Alabama

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The DUD, a year's end celebration in Livingston, Alabama, is quite nebulous in origin, structure, and organization; but it is a dynamic part of the civic and social life of the town of Livingston and surrounding area. Little has been written about the custom and not much interest is found in understanding its origin and meaning. Essentially, it is a custom deeply engrained in the mores of the area and people are inclined to feel that the "DUD is what you do on New Year's Eve."

James Anthony Froude (1818-1894)

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James Anthony Froude was one of the major English historians of the nineteenth century who ended his professional career as regius professor of modern history at Oxford University. Although a man of wide and varied interests and accomplishments, his main historical contribution was the monumental *History of England from the Fall of Wolsey to the Defeat of the Armada.* The principal theme of this study is, of course, the English Reformation.

Froude's writings have been the subject of long and bitter controversy, and during his lifetime he had many detractors, both in England and in France. In his presentation of historical material he became well-known for his lucid, flowing style and his ability in dramatic presentation. His work is marred, however, by numerous inaccuracies of detail and by pre-conceived judgments on various historical personalities and events. Nevertheless, the vividness of his writing and the clarity of his style mark Froude as one of the noted historians who successfully joined history with literature. He also assisted later historians by making known the vast amount of hitherto unused documentary material in the Spanish archives at Simancas which pertains to English history. In this respect he was a pioneer in laying the foundations for subsequent reinterpretations of the great age of the Tudors.

Medical Sciences

The Antiviral Effect Of Cycloheximide

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Cycloheximide (actidione), an antibiotic isolated from *Streptomyces griseus*, has exhibited a broad spectrum of biological activity. It inhibits growth of a number of yeasts and certain protozoa, but fails to inhibit the many bacterial species studied. The experiments were designed to demonstrate whether or not this compound possesses any antiviral activity. The procedure of Rightsel *et al.* employing virus-infected mammalian cells in culture was the system used. Cycloheximide markedly inhibited poliovirus (Type 2, MEF-1), herpes simplex virus, and parainfluenza (Sendai) virus. The compound showed moderate protection against parainfluenza 3 (HA-1) and measles. Adenovirus, Type 3 (Strain JF) was not affected significantly by cycloheximide. Additional experiments were carried out with poliovirus and herpes simplex virus to determine whether the drug exerts a true antiviral effect or a virucidal effect. Further studies were carried out to determine if the drug prevents entry of virus into the cell or if it interferes with some phase of the viral replication within the cell. The drug is not virucidal, nor does it prevent entry into the cell.

Effects Of Host Weight Loss Upon Friend Leukemia Virus Infections In Mice

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In vivo chemotherapy experiments using Friend leukemia virus (FLV) have indicated a need to know the effect of host weight loss upon splenomegaly induced by the virus, and upon the virus titer in plasma and spleen of infected mice. Three strains of mice, Swiss, DBA/2, BALB/c, were infected with FLV, caged individually, and placed upon the following measured diets of powdered Purina laboratory chow: *ad libitum*, 5.0, 4.0, 3.0, or 2.0 gm per day. After 14 days all animals were sacrificed and the body weight change, spleen weight and virus titer in spleens and plasma of each were determined. Splenomegaly in indicator Swiss mice, inoculated 21 days previously with dilutions of Selas 03 filtered spleen homogenate or plasma, was used to determine the titer of FLV in this material. In all experiments mice on restricted diets either gained less weight or lost weight compared to the *ad lib.* control animals. In each mouse strain this resulted in a significant reduction of splenomegaly. The virus titers per gm of spleen or plasma were not markedly affected by this loss of body and spleen weight. The results described were readily reproducible. Studies by others have shown that nonlethal drug toxicity can result in decreased food consumption and subsequent host weight loss. The data from the present experiments would therefore indicate that host weight change is important and should be considered when using FLV-induced splenomegaly in chemotherapy trials. It was also concluded from these studies that it is not essential to consider host weight change when evaluating drug effect on the amount of recoverable FLV per volume of spleen or plasma. (Supported by NIH Contract PH-43-63-68.)

Potentiation Of Ionizing Radiation By Selected Purine Analogs On Cultured Mammalian Cells

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A number of purine analogs show marked activity against a variety of neoplasms in both experimental animals and man. This group of anticancer agents interferes with nucleic acid biosynthesis. Although little is known concerning the mechanism by which ionizing radiation destroys either normal or tumor cells, it is known that ionizing radiation in some way affects nucleic acids in the cell. Experiments were designed to determine if certain purine analogs would potentiate the effect of ionizing radiation on KB cells in stationary cultures. KB cell cultures were exposed to approximately one LD_{90} of ionizing radiation following growth in medium containing varying levels of the selected purine analogs. Cultures were incubated for 14 days, fixed, stained, and macroscopic clones counted. In this study 20 purine analogs were evaluated. Of this group, eight compounds showed significant potentiation of the lethal effect of ionizing radiation.

The three compounds, 4-aminopyrazoloyprimidine (4-APP), 2-amino-6-benzylthiopurine (ABTP), and 6-mercaptopurine ribonucleoside (6-MPR), were the most effective potentiating agents in the group tested. X-ray doses which normally kill 80-90% of the cells in the absence of 4-APP would kill 98-100% of the cells in the presence of 0.25 to 5.0 mcg of 4-APP per ml of medium. Cells grown in medium containing 0.05 to 0.4 mcg of 6-MPR per ml and cells grown in medium containing 7.5 to 30 mcg of ABTP per ml and exposed to the LD_{90} of X-irradiation were affected in the same manner as cells exposed to 4-APP. (Supported by NIH Contract No. PH-43-62-485.)

Isolation And Characterization Of A Line Of H. Ep. #2 Cells Resistant To 2-Fluoroadenine

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As an aid in the study of certain adenine and adenosine analogs, previously shown to have growth inhibitory activity against tumors or cell cultures, a line of H.Ep. #2 cells was selected for resistance to 2-fluoroadenine (2-F-Ad). This cell line had normal amounts of IMP- and GMP-pyrophosphorylase activity, but essentially no AMP-pyrophosphorylase activity. The loss of AMP-pyrophosphorylase activity persisted when the cells were cultured for many generations in the absence of drug. Assay of the response of parent and resistant cell lines to a series of analogs — including, among other, 2-F-Ad, 4-aminopyrazolopyrimidine, 8-azaadenine, purine, 6-hydrazinopurine, and their nucleosides — gave a consistent pattern: the resistant cells were cross-resistant to the free bases but highly sensitive to the nucleosides. Several of the nucleosides were markedly more toxic than the free bases to both cell lines. These results suggest that a nucleoside kinase, presumably adenosine kinase, is the critical enzyme for the conversion of adenosine analogs to their nucleotides.

Aaron Lopez

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Aaron Lopez was born of Spanish-Jewish parentage on March 3, 1800 in Charleston, S.C. He married his first cousin, Eleanor Cohen of Georgetown, S.C. on Jan. 23, 1818 and ten of their children reached adulthood.

Dr. Lopez came to Mobile, Alabama about 1840 and opened his office for the practice of medicine. He soon became interested in

organized medicine. He was one of the organizers of the Medical Association of the State of Alabama in December, 1847 and served as temporary chairman until permanent officers were elected. Dr. Lopez moved that a committee be appointed to prepare a code of ethics. Dr. Lopez was present at the first meeting in Selma in 1848 when he was elected a delegate to the American Medical Association.

He was elected president of the Medical Association of the State of Alabama in 1849 and gave the presidential address at the Mobile meeting in 1850. He was elected a Vice President of the American Medical Association in 1850. He served on several committees of the latter organization.

Dr. Lopez presented the annual oration of the Medical Association of the State of Alabama in 1854. He served on many committees of the state association but probably one of the most important ones was the Special Committee on Hospitals and Asylums in Alabama. Being interested in mental health he exerted a great influence in establishing the Bryce Hospital.

Dr. Lopez suffered a stroke and retired from the practice of medicine. He moved to Memphis to live with his son Joseph who was president of a railroad. Dr. Lopez died in Memphis on August 18, 1873 and was buried in Elmwood Cemetery, Memphis.

Richard Fraser Michel

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Richard Fraser Michel was born in Charleston, S.C. on February 15, 1827 of French-Scotish ancestry. He was graduated from the Medical College of the State of South Carolina in 1847.

In 1848 he joined his brother, Dr. William Middleton Michel who established the Summer Medical Institute of Charleston. Richard was appointed Professor of Materia Medica, a position he held until 1861.

After serving as surgeon of the First South Carolina Artillery in the Army of Northern Virginia, during the Civil War, Dr. Michel located in Montgomery where he opened his office for the practice of medicine.

He wrote papers on malarial fever, haemorrhagic fever and yellow fever. He was active in the medical societies. In 1866 he was one of the founders of the Montgomery Medical and Surgical Society and served as its president in 1869. Dr. Michel was elected president of the Medical Association of the State of Alabama in 1869 and vice-president of the American Medical Association in 1872. He was orator of the State Association in 1876. He was official delegate to the American Medical Association at several sessions.

Dr. Michel served as a member of the Board of Health of Montgomery for more than twenty five years and was president of the body part of the time. He served as a member of the Montgomery County Board of Examiners. In 1883 Governor O'Neal appointed Dr. Michel to his staff.

Dr. Michel died in Montgomery on April 19, 1907.

Some Cortical Efferent Pathways Of The Opossum

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The connections of certain efferent areas of the opossum neocortex have been studied. The Nauta-Gygax technique for degenerating preterminals and terminals and the Marchi method for degenerated myelin have been utilized to follow degenerating nerve fibers of cortical origin in animals with motor cortex lesions. Electrical stimulation studies were also performed to determine the neocortical areas which initiate somatic movements.

A pattern of responses was observed from stimulation of the orbital cortex which involved only the forelimb, neck, and face. Ablation of the orbital area resulted in degeneration in the pontine nuclei, the nucleus of the spinal fifth tract, the cuneate nucleus, (but not to the nucleus gracilis) and into the dorsal horn and intermediate area between the dorsal and ventral horns of the cervical cord. Degeneration was observed passing into the posterior part of the lateral nucleus of the thalamus following lesions which included the parietal cortex. Direct fibers of orbital origin have not been traced caudal to lower cervical levels. Cortical projections have been followed to extrapyramidal areas including the putamen and to a lesser extent the caudate, the substantia nigra, the red nucleus, and the tegmentum of the mesencephalon and lower brain stem levels.

The cortical influence on the somatic motor activity of the hind limb of the opossum is through the indirect extrapyramidal system which has been demonstrated in many mammals. Direct cortical projections to the cervical cord provide additional pathways regulating forelimb activity in the opossum.

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Congenital Diaphragmatic Hernia In The Domestic Cat

James D. Yarbrough and Herbert T. Boschung, Jr.
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University of Alabama, University

INTRODUCTION

The lack of salient external signs make it difficult to evaluate the occurrence of congenital diaphragmatic hernia in the domestic cat, *Felis domestica.* Consequently the anomaly may be more common than the number of reported cases indicate. Newcomer (1945) and Kent (1950) compiled records of only seven cases spanning 32 years. The present report includes three instances of diaphragmatic hernia observed in preserved laboratory cats.

DESCRIPTION OF AFFECTED CATS

Case I: An adult male, measured 52 cm, from tip of nose to base of tail. The right side of the diaphragm was absent save a small muscular isthmus attached to the sternocostal surface, resulting in an oval foramen measuring approximately 3 by 4 cm. The isthmus originated from the cranial end of the right kidney and inserted on the central tendon and formed the ventral border of the foramen. The right kidney was displaced cranially and formed a portion of lateral border of the foramen (Fig. 1). The dorsolateral border was bounded by the rib cage and connective tissue. The median border was formed by a continuous muscular isthmus attached to the central tendon and to the sternocostal surface. The left side of the diaphragm was normal.

The small intestine, a portion of the pancreas, the cranial and caudal divisions of the right lateral lobe of the liver, the ascending colon, a portion of the greater omentum, and the associated blood vessels protruded through the diaphragmatic opening into the right pleural cavity. Due to the transposition of abdominal viscera the lungs and heart were displaced to the left. The lungs were compressed dorsally, the heart was rotated to the left and approximately 75 degrees on its longitudinal axis. As a result, the aorta arched to the right related to the heart (Fig. 2). The thoracic aorta maintained its normal orientation to the left of the vertebral column. The ventral mediastinum was forced flush with the left thoracic wall. There was a foramen, approximately 1 cm, in diameter, through the dorsal mediastinum near the diaphragm connect-

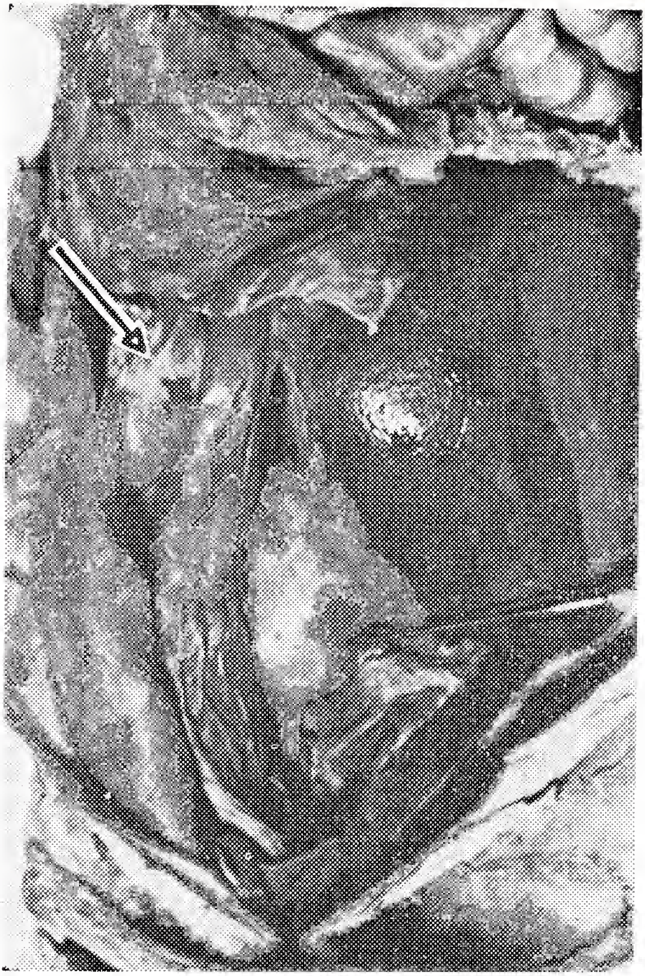

FIGURE 1. Ventral view of abdominal contents in Case 1. Right kidney marked by arrow, showing extreme cranial displacement in relation to left kidney at end of probe. The colon, is a straight tube running from the diaphragmatic foramen, which is concealed by abdominal musculature, into the pelvic cavity. The left medial and lateral lobes of the liver are present.

ing the right and left pleural cavities. The cisterna chyli was greatly enlarged.

The viscera which remained in the abdominal cavity were essentially normal. The pancreas was elongated, its head was pulled through the foramen by the ascent of the duodenum. The left kidney and spleen were normal in position; the transverse colon and descending colon followed a straight course from the herniation to the rectum (Fig. 1). The stomach, urinary bladder and sex organs were also normal in position. The right median lobe of the liver displayed some abnormal adhesions to the diaphragm. The only abnormal vessels observed were double renal arteries. The abdominal arteries arose normally from the aorta and followed the transpositioned organs.

In addition to the above anomalies, the cat exhibited a polydactyl condition. This appears occasionally and is of genetic nature (Danforth, 1947). The occurrence of polydactylism with diaphragmatic hernia is apparently coincidental.

Case II: An adult male, measured 48 cm. from tip of nose to base of tail. The diaphragmatic foramen was approximately the

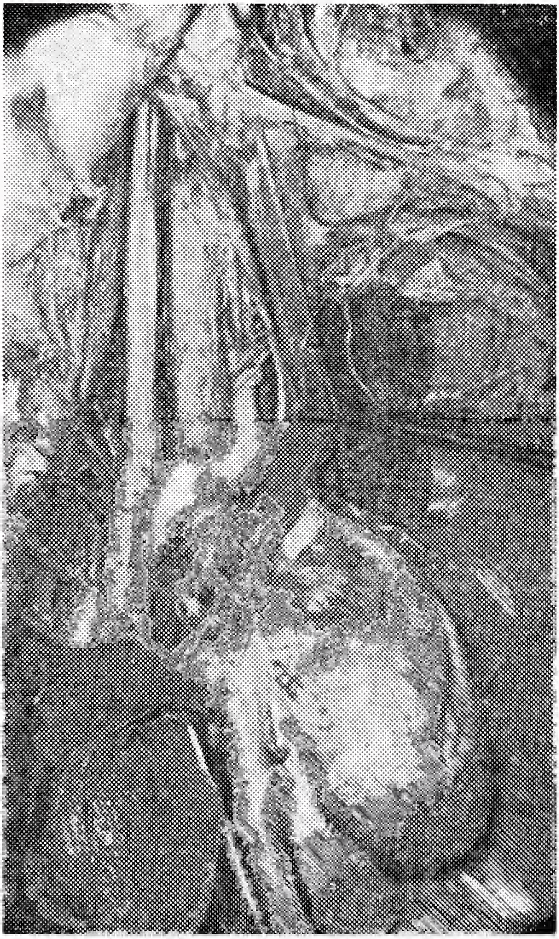

FIGURE 2. Ventro-lateral view of the thoracic cavity of Case I with mediastinum and abdominal viscera removed. The heart is shifted left with the aortic arch consequently being to the right. Trachea cut and lungs are removed to show complete aortic arch. The compressed left lung is seen under the probe.

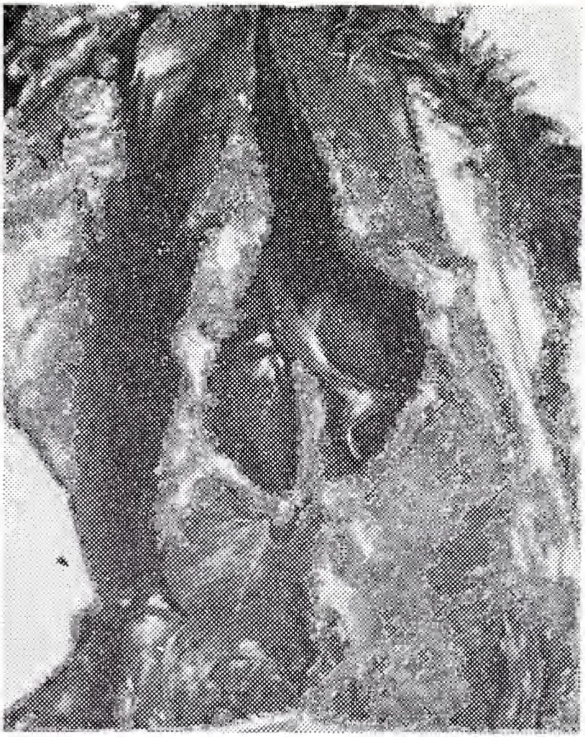

FIGURE 3. Ventral view of the cat showing the inferior surface of the diaphragm in Case 2. All abdominal viscera has been removed from thoracic and abdominal cavities. The heart can be seen compressed dorsally and to the left.

same size as the one reported in the first case. The mid-ventral portion of the diaphragm was absent, so that the ventral border of the foramen was formed by the sternum and rib cage. Portions of the central tendon, both right and left side were absent, with the dorso-lateral borders of the foramen being formed by the costal and vertebral aspects of the diaphragm (Fig. 3).

The small intestine, greater omentum, stomach, a portion of the pancreas, two-thirds of the spleen, and three lobes of the liver were prolapsed through the foramen into the right pleural cavity (Fig. 4). The lungs were compressed dorsally, the heart was rotated, but the rotation was not as extreme as the one in Case 1. The abdominal cavity contained two liver lobes, large intestine, a portion of the duodenal loop which ascended through the foramen and the ilio-colic portion of the intestine. The urinary and reproductive organs were in normal position. No other anomalies were observed.

Case III: In a third case observed by us, but not described in detail due to the poor condition of specimen, the diaphragmatic foramen was large, due to absence of most of the right side and approximately one-third of the left side of the diaphragm. However, prolapse of abdominal viscera was not appreciably greater than in the cases described above.

DISCUSSION

Based on the criteria of Kent (1950), these are congenital conditions, that is, a portion of the diaphragm is absent, there is a smooth-edged foramen, with no adhesions, indicating no rupture of tissue. The rotation of the heart, position of lungs, the right curvature of the aorta, are of secondary nature, resulting from the pressure of the prolapsed intestinal viscera.

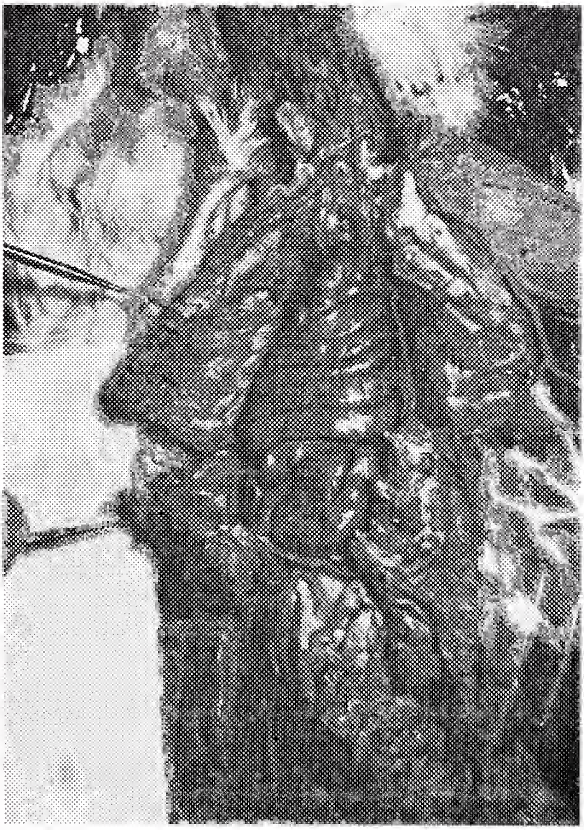

FIGURE 4. Ventral view of the thoracic and abdominal cavities of Case 2. The omentum has been removed from the intestines, which are prolapsed and coiled in the right plural cavity.

The role of the diaphragm in respiration is somewhat uncertain. Day (1939) reported the complete absence of a diaphragm in a cat which showed no apparent developmental or functional incapacity. It is possible, that the herniated viscera served to plug the foramen, thus preventing complete loss of thoracic vacuum.

There seems to be no correlation of size of opening with displacement of viscera. These cases, as well as Newcomer's (*op. cit.*) demonstrated drastic prolapse into the thoracic cavity, yet the actual size of the foramen is relatively small. Day's (*op. cit.*) case, without diaphragm, showed much less prolapse of abdominal viscera into the thoracic cavity.

SUMMARY

Three cases of congenital diaphragmatic hernia in the domestic cat are reported. Each case involved the loss of rather large segments of the diaphragm thus allowing the abdominal viscera to prolapse into the thoracic cavity with the result of shifting and compression of the thoracic viscera.

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Concepts Of Economic Development As Applied To North Alabama

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Ever since Adam and Eve were evicted from the Garden of Eden, man has dreamed of a world of luxury, if not an actual return to the original utopia. As he has wandered through the centuries, he has been concerned with providing an adequate supply of food and an ever-widening set of options in satisfying an ever-increasing desire for an improved standard of living.

From the days of Aristotle and other early Greeks, to the Physiocrats, the Mercantilists, Adam Smith, and the classical economists, to present day philosophers and social scientists, attempts have been made to explain the workings of our economic and social system and to point the way for reaching a higher plateau of material satisfaction.

Today, there is a tremendous body of literature concerning economic development. Yet, substantial gaps exist in our knowledge, first, particularly in understanding noneconomic characteristics of development such as the effects of attitudes, values and the social structure; and secondly, concerning the lack of adequately developed theories of the nature and causes of orderly economic development and the public and private policies necessary to bring it about.

These gaps in knowledge are particularly apparent when discussing regional development, partly because most of the literature is concerned with underdeveloped countries or national development problems, and partly because regional development involves a complex set of interrelationships with the national economic system. To further complicate matters, the planning and reporting of basic data involve a host of overlapping geographical units relating to political, economic, social, or watershed boundaries with relatively free mobility of people and capital. Instead of dealing with a closed economy, we are in reality concerned with a set of activities and flows which frequently have indistinct boundaries; or where logical geographical boundaries change as we change from a water development plan to a social system, to political units, or to a labor market.

Measures of Growth

What do we mean by "measuring" economic growth? Economists generally talk about such things as increases in total employment, total economic activity, population, and per capita income or standards of living. These various indicators can be divided into two categories: those involving the bigness of the economy and those concerned with the welfare of individuals.

This distinction is important. As a region, a state, or a nation, we have choices from which to select the path we wish to follow. Studies of the various regions of the United States indicate that, for most areas, the attainment of bigness and a high level of welfare can be competitive. Historically, for example, population increases in agricultural areas in the South and elsewhere have disturbed a favorable balance of resources to people, resulting in the division of farms into uneconomical units and a low per capita income. A study by Harvey S. Perloff and others reported in *Regions, Resources, and Economic Growth* indicates that from 1939 to 1954 only a few southwestern states were able simultaneously to increase population, total income, and per capita income at a rate greater than the national average.

Economists generally believe that while at certain times an emphasis on an increase in population or total income may be important to the desirable development of an area, neither of these is of such general importance as are increases in per capita income. Many social scientists would go further and state that such measures as per capita income are heavily weighted toward material goods and that they measure the quantity rather than the quality of an area's development. Edward K. Faltermayer, in an article titled "The Half-Finished Society" in the March 1965 issue of *Fortune*, argues that our American civilization is only half built. From the standpoint of per capita consumption of goods, we lead the world; but in emphasizing the individual's demands for material comfort, we have largely ignored the other half of civilized life—a whole spectrum of human needs, as well as improvement in our physical environment.

Today, we frequently link the terms "economic development" and "social change" so as to emphasize the more basic goals of society and the interrelationships between our economic institutions and our social and political institutions.

Theories of Regional Development

Taking into consideration the theories of regional development, there are several concepts of interest applicable to the north Alabama area.

In speaking of economic growth, economists traditionally consider capital formation, improved technology, and the existence of adequate entrepreneurship as the three most important factors. With regard to regional development, these resources can be generated from within or can be attracted from other areas.

The export base theory of development emphasizes the role of production of goods and services for consumption outside the area as the crucial factor in economic development. Capital tends to flow into businesses and areas producing for export to a larger area. The resulting increase in income will tend to augment demand for secondary products and to foster investment in a variety of other industries.

There are several implications of this theory regarding economic growth in north Alabama. First, cities and local areas which are more or less self-contained, where employment serves mainly the local needs, are not likely to grow as fast as other areas which produce goods and services for a larger market. Secondly, it emphasizes the dependence of north Alabama on developments within the Southeast and the Nation and on international trade. Growth in the broiler business, for example, is highly dependent on expanding markets in other regions and on international trade, as well as on competition from north Georgia, Arkansas, and the Delaware-Maryland-Virginia area.

A sector theory of development emphasizes the internal structure of the economy. Writers such as Colin Clark and Allan G. B. Fisher have observed that per capita incomes tend to rise as the proportion of the labor force progressively shifts from primary industries, such as agriculture, forestry, and mining, to secondary industries involving manufacturing, and then to tertiary or service industries. Thus, development is seen as an internal evolution of specialization and division of labor. Sector shifts are seen as the central focus of economic advance.

The "big push" approach toward economic development suggests that an economy does not get off the ground with small injections of capital but that a concentration of activity is needed to launch a sustained growth economy. Within the north Alabama area, the city of Huntsville is a classic example of massive government injections of capital which build a growth economy attracting both supporting and other businesses.

The "thrust," or unbalanced, concept of development emphasizes the lumpiness of growth and the possibilities that imbalance, or a major thrust or breakthrough, in an economy can serve as an irritant to all sectors, causing faster growth than if development is attempted in a balanced fashion. For example, the initiation of an industrial park with the resulting attraction of an industry might cause severe tensions in transport, in water supply, in housing, and in deficiencies in other services. The point of the argument is that the tensions created may spur community officials and service firms to bridge the gap, resulting in employment of more resources than if developmental efforts were allocated evenly among points of need.

When our locational advantages and natural resources attract an industry into north Alabama, we frequently import the necessary capital and top management and have little responsibility for developing improved technology. When this is our sole objective, we have little control over our rate of growth or our means of earning a living.

A common strategy of regional development is to develop policy, establish institutions, and take action to do a better job of attracting industry. This includes such things as establishing incentives, industrial parks, and information programs to acquaint corporate management with opportunities in the region. A second strategy is to develop natural resources and locational potentials. An improved system of highways, for example, is a major cornerstone of the program for Appalachia. The development of the Tennessee River, including navigation, flood control, and low-cost power, has been a major development force in north Alabama.

In a larger sense, it seems apparent that sustained economic growth and long-range improvement in per capita income require more active participation in originating economic activity, in capital formation, in developing technology which can make fuller use of the human and natural resources of the area, and in developing future business institutions and management. This requires a heavy investment in people, primarily in education, and other investments in our environment to make a more attractive and satisfying place in which to live. In line with this view, the mayor of a southern city recently said that if his city was beautified and had an adequate program of education for its youth, then employment opportunities would largely take care of themselves.

The nature of economic development suggests that many of the crucial decisions must be made by the people of an area because it involves basic changes in the way people earn a living, in the way they live, in the degree to which they tax themselves, and in the extent to which they are willing to risk resources to obtain desired objectives.

It is also essential that we recognize the new relationships which are developing between urban and rural sectors of our regional economy. While more and more of the population growth and employment take place in cities, these two sectors are also becoming more and more interrelated. It is becoming more and more vital that planners and policy makers recognize this interrelationship and plan for more effective land and water use to maximize benefits to all.

Deformational Variation Across Strike In The Mississippian Sandstone—Shale Sequence Of The Southernmost Appalachians

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In the southernmost Appalachians, in the vicinity of Birmingham, Alabama, the upper Mississippian sandstone and shale sequence crops out in three distinct belts, which follow the general northeast-southwest Appalachian strike, and in a small "cross-belt" which trends perpendicularly to the normal Appalachian strike and which connects two of the major outcrop belts (Fig. 1). The sequence here in question is stratigraphically underlain by the Ft. Payne Chert and overlain by the Pottsville Formation. It is made up of the Floyd and Parkwood formations which consist of interbedded sandstones and shales. The Parkwood characteristically contains more sandstone than the Floyd. If the metamorphosed sandstones and shales of the Talladega Slate, to the southeast of the four Mississippian outcrop belts, are at least partially of Late Mississippian age (personal communication from T. J. Carrington), then five outcrop belts may be considered (Fig. 1). The area of the five outcrop belts is characterized by fairly typical Appalachian deformation. The different outcrop belts result from repetition of the sequence by folding and thrust faulting.

The purpose of this paper is to make a comparison of the generalized structural geology of the five outcrop belts, with particular emphasis on the relative degree of deformation exhibited in the belts as related to their relative geographic positions. The structural data presented in this paper were collected during the course of a regional field study of Mississippian stratigraphy of Alabama. The stratigraphic studies have been sponsored by the National Science Foundation and the California Company and have been under the direction of William A. Thomas.

The most northwesterly outcrop belt is on the northwest slope (outcrop slope) of Shades Mountain and may thus be referred to as the Shades Mountain belt. Structurally, it is located on the southeast flank of the Birmingham Anticline and consists of interbedded coarse and fine grained clastic rocks dipping southeastwardly at 6 to 25 degrees. Significant variations in dip occur gradationally over large areas and no small scale structures are found (Fig. 2).

The only structural complications in the Shades Mountain belt are found at Trussville and just south of Bessemer (Fig. 1). At

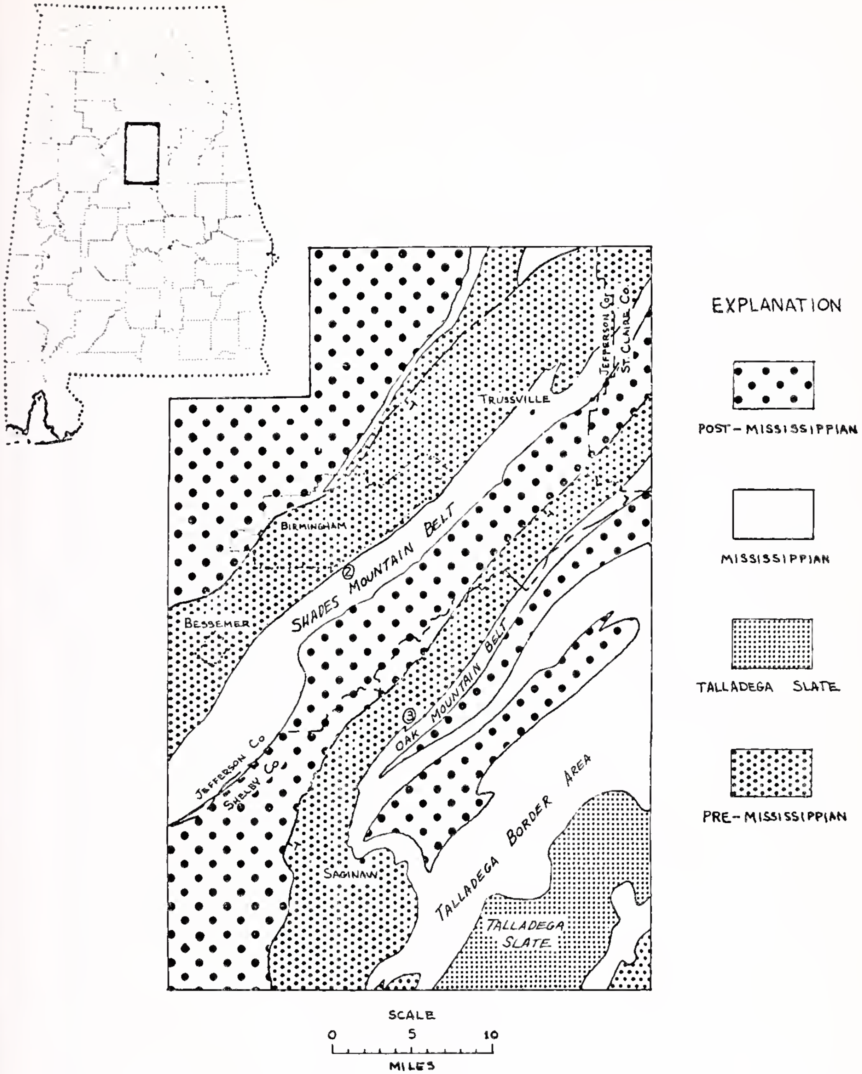

FIGURE 1. Geologic map of the Birmingham Area, Alabama, showing outcrop belts of the Mississippian sandstone-shale sequence (from Geologic Map of Alabama, Alabama Geological Survey, 1926).

Trussville, a secondary anticline noses out on the flank of the Birmingham Anticline, and approximately doubles the width of the outcrop belt. South of Bessemer, a normally faulted dome on the flank of the Birmingham Anticline causes some of the section to be repeated and approximately doubles the width of the outcrop belt. However, even in the areas of structural complication at Trussville and south of Bessemer, there is no small scale disharmonic folding.

The next outcrop belt to the southeast comprises the northwest slope (outcrop slope) of Oak Mountain, and may thus be called the Oak Mountain belt. Major units of competent beds in the Oak Mountain belt are structurally similar to the entire sequence in the Shades Mountain belt, with southeastward dips ranging from 21 to 70 degrees. However, in sequences of incompetent beds or interbedded competent and incompetent beds, both strike and dip have wide ranges; and complicated, minor structures are common. In the incompetent or incompetent-competent sequences, the sandstones acted in a competent manner, but the relatively incompetent shales were exceedingly crumpled and in some localities apparently "flowed." This deformation resulted in pinching and swelling of the incompetent sequences and closed folds in the competent units. In some localities, stratigraphically successive competent beds were apparently able to act more or less independently and disharmonic closed folding resulted. The structures typical of the incompetent-competent sequence are shown most graphically in the southwestern part of Oak Mountain State Park in Shelby County (Fig. 3).

At the southwestern end of Oak Mountain, the rock sequence making up the Oak Mountain belt is located on a major synclinal nose. The beds in this fold connect the Oak Mountain belt to the next outcrop belt to the southeast. Because the rock sequence involved in the fold exhibits deformational characteristics distinct from both the Oak Mountain belt and the next belt to the southeast, it may be considered as a separate outcrop belt, which is called the Saginaw belt for the town of Saginaw located near its center (Fig. 1). The Saginaw belt is structurally like the Oak Mountain belt, except that it apparently has more folds, many of which have their axes trending at odd angles with respect to each other and with respect to general Appalachian strike. Also, slaty cleavage is developed to some extent in the incompetent beds of many of the outcrops, and in a number of instances at a significant angle to bedding.

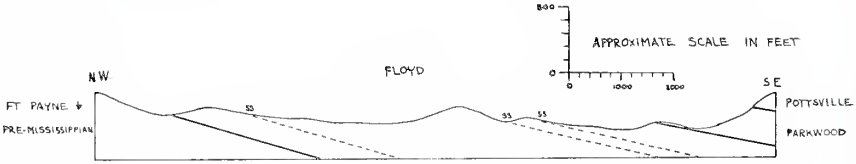

FIGURE 2. Structural cross-section of the Shades Mountain belt showing lack of small scale folding in the incompetent Mississippian sequence.

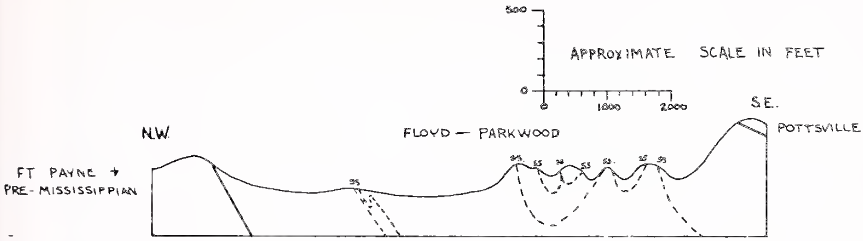

FIGURE 3. Structural cross-section of the Oak Mountain belt showing small scale disharmonic folding in the incompetent Mississippian sequence.

The next outcrop belt to the southeast is bordered on the south by the Talladega Slate and is referred to as the Talladega Border belt (Fig. 1). Deformation of the sandstone beds in the Talladega Border belt appears to be greater than in the Oak Mountain belt. Rather poor, scattered outcrops show extensive slaty cleavage, highly contorted bedding, and relatively few competent beds. Also, the rather low relief of the area indicates that the entire sequence weathers and erodes similarly, perhaps indicating that the sandstone beds have been more or less disintegrated to destroy competency in the sequence. The Talladega Border belt is probably more deformed than the Saginaw belt.

The most southeasterly of the outcrop belts is the Talladega Slate. The rocks of this belt may or may not be wholly or partially Mississippian in age. In any event, the sequence appears to be lithologically similar to the incompetent Mississippian sandstone-shale sequences of the outcrop belts to the northwest. The Talladega belt is characterized by low grade, fine grained metamorphic rocks, with some interbedded fine- to coarse-grained sedimentary rocks. The rocks of the belt are generally very contorted and extensively fractured, and slaty cleavage is generally developed. There are major units of relatively competent rocks within the Talladega belt, but only rarely is a thin competent bed or unit present in a sequence of otherwise incompetent rocks. Only in rare outcrops has bedding been completely obliterated by deformation, but it has generally been greatly contorted and obscured by the deformation.

Thus, the deformational variation in the area of the five outcrop belts considered in this paper has a very clear pattern. The degree of deformation increases in a southeasterly direction, with the most northwesterly of the belts having only broad, gentle deformation and the most southeasterly of the belts having so much local, minor deformation and metamorphism as to almost obliterate any major structures which might be present. From this pattern, it appears that the primary force responsible for the deformation and metamorphism came from the southeast; diminished in intensity to the northwest, because of the relative inability of the grossly incompetent sequence to transmit forces laterally; and finally became ineffective as a deformational force just northwest of Birmingham.

Pea Ridge. Does It Preserve "Fossil" Stratigraphy?

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One of the most striking physiographic features on Sand Mountain is modestly named Pea Ridge. It rises about 400 feet above the average elevation of the eastern edge of the plateau, just north of Alabama Highway 40 and about 1½ miles west of Whitcoak Gap where Alabama 40 (from the west) and Alabama 117 (from the north) descend together into Wills Valley.

The Stevenson Folio (Hays 1895) does not mention Pea Ridge in the general description of the topography although it is shown and named on the topographic map, nor does Hays mention this feature in an earlier work (1892).

Gibson (1886) still earlier, however, does mention Pea Ridge and speculates upon the possibility that certain prolific coal bearing strata of southern Tennessee may be represented in Pea Ridge. He said:

"All the coal as yet developed in this portion of the field belongs to the Sub-conglomerate class. Yet there is every probability that Super-Conglomerate coals exist. There are a few places where the measures have not been denuded down to the Conglomerate, notably the Pea Ridge region. Here a great thickness of Super-Conglomerate strata has been left. They occupy the same geological position as the measures of the great Sewance Seam, and it is very probable that an intelligent and persistent search for coal here would be richly rewarded.

"The Sewanee Seam is one of the most important that has yet been opened in the State of Tennessee and if its equivalent can be found in this region, it would add vastly to the value of this coal field. Unless such discoveries should yet be made, in the Super-Conglomerate Measures, all the mining will have to be done from the edges of the mountains, or by deep shafts penetrating through the conglomerate rock and other intervening strata."

It will be noted that Gibson was convinced that Pea Ridge was an erosion remnant in which were preserved much younger strata than found anywhere in the surrounding area. He evidently found no indication that the ridge resulted from the differential erosion of faulted Upper or Lower Conglomerate beds which occur around the base of Pea Ridge. The present writer agrees with Gibson's conclusion but there are a few indications that structural distur-

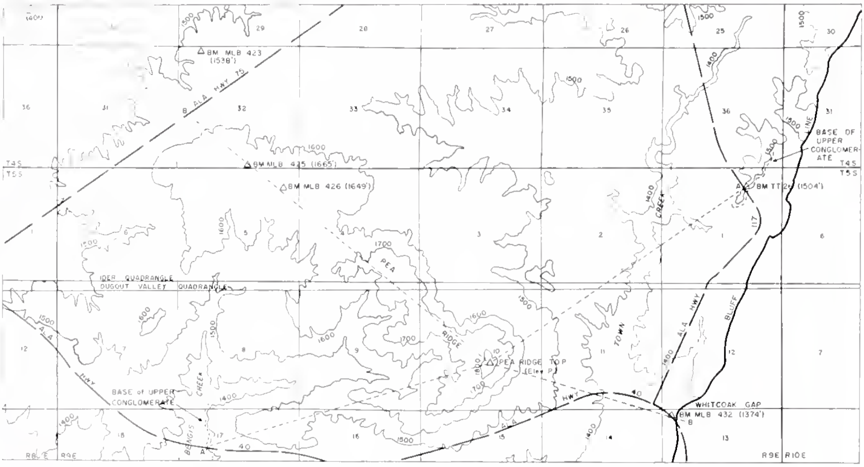

FIGURE 1. Topographic map of Pea Ridge and surrounding Area.

bances could exist in the area and these might have contributed to the present form of Pea Ridge. Three quick trips over the ridge, one trip around it and the scanty stratigraphic observations shown on Figs. 2 and 3, were insufficient finally to decide the question. Certainly this interesting area deserves some detailed structural and stratigraphic study.

Figure 1 is a topographic map of Pea Ridge and surrounding area, with only the 100 foot contour lines shown. The 1600, 1700 and 1800 foot contours show Pea Ridge proper to be a long narrow mass with these features:

1. The ridge runs essentially at right angles to the brow of Sand Mountain, to the strike of the strata and to the structural "grain" of the mountain. Hayes (1892) indicated the synclinal axis of Sand Mountain approximately follows Alabama Highway 75.

2. It is very steep on the southeast end with a long, rather gentle back slope in the northwestern direction.

3. Town Creek is only about ½ mile east of the steepest part of Pea Ridge and only about ½ mile west of the brow at Whiteoak Gap. Bengis Creek, almost paralleling Town, heads against Pea Ridge but on the northeast side of the ridge only short tributaries of Town Creek flow away from it. Town Creek apparently is the oldest stream in the area.

Figures 2 and 3 show the topographic sections indicated on Fig. 1. Section AA runs southwest to northeast across Pea Ridge from the Alabama Highway 40 bridge across Bengis Creek to Alabama 117 at BM TT 26 near Mountain Home Church, thence to the foot of the escarpment made by the Upper Conglomerate. Section BB extends across the highest part of Pea Ridge from Alabama 75 to the foot of Sand Mountain at Whiteoak Gap.

The base of the Upper Conglomerate, on Bengis Creek, is about 85 feet lower than it is approximately 5 miles northeastward, near Mountain Home Church and BM TT 26. As Sand Mountain is a shallow syncline, pitching southeastward, this is the expected relation. In this case, however, the thick sandstone outcropping on Pea Ridge at around 1630 ft. elevation is not the Upper Conglomerate but another sandstone high up in Hays' (1895) Walden formation. Apparently, the only condition that could alter this conclusion would be a fault of about 200 feet displacement extending from the "embayment" at Whiteoak Gap northwestward along the northeastern flank of Pea Ridge.

Figure 3 supports the assumption that the massive sandstone of Pea Ridge is very much higher than the Lower Conglomerate. As the Upper Conglomerate (Fig. 2) is only about 50 feet above the Lower near Mountain Home Church, the high sandstone is also much higher than the Upper Conglomerate. It also appears that the massive, dense sandstone that outcrops around Pea Ridge Cross Roads (and BM MLB 425) is the same sandstone that outcrops at about 1630 feet on the southeastern end of Pea Ridge. This

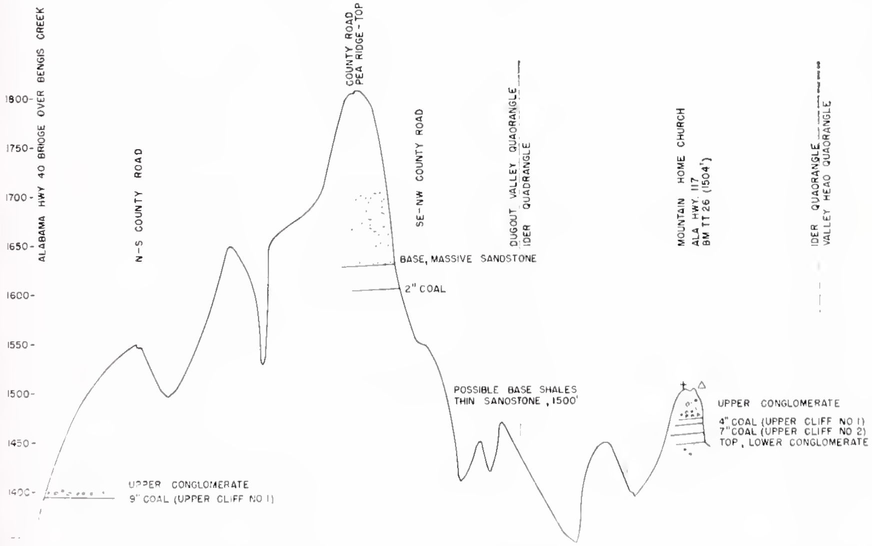

FIGURE 2. Topographic Crossection over Pea Ridge from Bengis Creek Bridge on Alabama Highway 40, Northeastward to Mountain Home Church on Alabama Highway 117. Section A-A, Fig. 1.

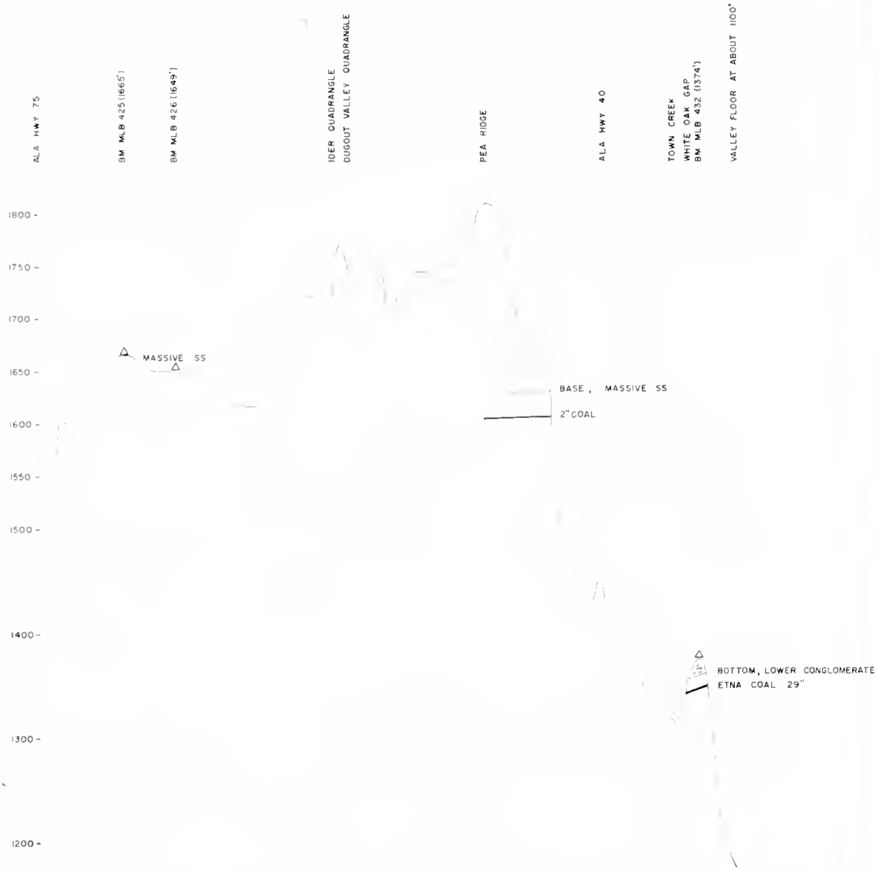

FIGURE 3. Topographic Crossection over Pea Ridge from Alabama Highway 75 near Pea Ridge Cross Roads, Southeastward to Sand Valley Floor East of Whiteoak Gap on Alabama Highways 40 and 117. Section B-B, Fig. 1.

sandstone seems to form a broad, lower pedestal upon which the higher strata of Pea Ridge rest.

Figures 2 and 3 show a 2-inch coal bed about 30 feet under the massive sandstone. It was a rather poor one, apparently consisting of about as much iron oxide as coal, on the outcrop. It was the only one of Gibson's "Super-conglomerate" coal beds found although the writer's search may have been neither "intelligent" nor "persistent"! If the Pea Ridge section is compared to that of Lookout Mountain, as given by Culbertson (1962), the thin bed should be the equivalent of the Sewanee or Tatum coal. This, in turn, should make it the equivalent of one of the Whitewell shale coals of Raccoon Mountain in Tennessee (Kelly, Slate, Oakhill) and of beds No. 4 and No. 5 on Lookout Mountain in Georgia. Johnson

(1946) termed the interval carrying beds 4 and 5, the "Vandever shale" and mapped no occurrences of these beds on Sand Mountain. Culbertson (1962), perhaps correctly, identifies it as the Whitewell shale. Accepting these correlations, the thick sandstone at 1630 feet on the southeast end of Pea Ridge would be in the position of the Newton sandstone of Tennessee (Wilson, *et al,* 1956).

A private communication from R. L. Wilson (1946) indicated that he considers that Upper Conglomerate of Hays (1895) and McCalley (1891) to be the equivalent of the Warren Point sandstone of Tennessee and not of the Sewanee, as assumed by Culbertson (1962). In this case, the 2-inch coal bed in Pea Ridge corresponds to the Upper Wilder (Angel, Ranvenscroft) coal of Tennessee in the Signal Point shale interval and the thick sandstone at 1630 feet would be the Sewanee sandstone.

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The Economic Theory Of Industrial Development

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Industrial Development in its proper perspective is a subordinate but relevant phase in the whole sum of economic development. The total economy consists of many facets of activity each of which contribute in some measure to an organized society. When we examine industrial development in its relationship to other activities we find it is basically a balance of trade expedient.

It is axiomatic that any community, trading area or state as a part of a broader commonwealth, must maintain a favorable balance of trade if it is to sustain an economy above subsistence level. No area can be self-sufficient in all of the accouterments of daily living as we enjoy it today. All communities or areas must import from other areas all, or a part, of such things as automobiles, gasoline, furniture, clothing, television sets and refrigerators, to name a few. Money to pay for these items must be sent away from the area. Unless there is money coming into the area from some outside source the area will become depressed. At one time depressed communities were called "ghost towns."

Generally, an area must produce a significant quantity of merchandise to ship away and sell in other areas, export if you will, so as to get fresh dollars with which to pay for its imports. There are exceptions, such as areas with large government installations close at hand or communities that are seats of universities. Some areas are prosperous as a result of tourist attractions, however, most areas with a normal economy must produce and ship if they are to survive.

If this area balance of trade concept is accepted as a working hypothesis, the direction in which to work for economic improvement of an area is more clearly defined. We can then think in terms of what types of enterprises will best serve this purpose. Under this broad definition there appear to be four basic wealth-producing industries. They are: agriculture including forestry, mining, manufacturing and commercial fishing. These basic wealth producing industries help provide a favorable trade balance for the areas in which they are located and are the foundation of a sound prosperity. Wholesale and retail distribution concerns, local consumption industries and service facilities contribute nothing toward creating basic wealth and normally do not improve the area trade balance. However, their functions are absolutely necessary to an organized community. Further, they may be considered multipliers of dollars in that a dollar coming into a community is passed around between service concerns, retailers and other purely local concerns several times before it is finally sent away to pay for some import. Each time it changes hands it is assumed to be a profitable transaction. And each time it changes hands a tax bite is taken out of it to support schools and government services. These activities are a most important facet in economic development.

Industrial development is generally and correctly thought of as being concerned with the manufacturing and processing phase of economic development. There is, however, a common interest between the production of raw materials and processing.

We in Alabama have long been producers of agricultural raw materials with the minimum of facilities for processing these materials into finished consumer products. An area which has finished and packaged consumer products to sell rather than raw or semi-finished products receives the full benefit of value added by manufacture. For example, the retail market value of a loaf of bread may be 22c whereas the market value of the wheat that went into the bread is about 3c. The market value of a cord of pulpwood is about $5.00. If processed into pulp the market value would be $75.00, if further manufactured into paper the value added would be much greater depending on type of paper made. Similar relations exist between a pound of fresh shrimp at dock side and a package of pre-cooked frozen shrimp in the super market.

From these postulations it may be assumed a local economy will prosper in relation to its capacity to produce and ship. Further, the more value added by manufacture an area can accrue by processing finished consumer products, especially those that may be derived from local raw materials, the more favorable its trade balance will be.

The function of industrial development is to encourage more manufacturing and processing. Thus, we may undertake to delineate our procedures. To best accomplish our purpose, three avenues of approach are designated. Perhaps the most dramatic is that of attracting new industrial plants as branch operations of firms established outside the area. The second approach is expansion of existing industry. The third method is the creation of new industry from within the area by local people making use of local resources.

Procedures for attracting new industry into an area are well defined. It is not reasonable to suppose any industrial development effort could ever "sell" a company the idea of building a new plant.

The need for a new plant must arise or be generated within the parent company. When a company is known to be interested in expansion involving the building of a branch plant, the company becomes known as a "prospect" for industrial development groups. The industrial development worker presents to the prospect the locational factors characteristic of his area and pertinent to the company's requirements in the most favorable manner he can devise.

Several well organized and efficient agencies are working at this in Alabama. The fact that some $175,000,000 was invested in new plants in 1964, which was the largest annual investment ever made, is its own testimony for the work of these agencies.

Expansion by existing industry, while less spectacular than the opening of a new plant, has in successive years resulted in greater capital investment and a larger number of new job opportunities. For example, in 1964 capital investment in the expansion of existing industry was $231,000,000 as compared to the afore-mentioned $175,000,000 invested in new plants.

When an industry operating in Alabama feels the need for additional capacity, it is to our best interests for the expansion to take place here rather than have them open or expand a plant elsewhere. Nevertheless, expansion will be made where it is likely to be most economical and profitable for the company. Factors of a social and political nature which have some effect on the economic well being of an industry are referred to as "business climate." A business climate conducive to a healthy and profitable operation is one in which there is an equitable tax structure. Workers must be available. Because of the way the highly competitive business and industrial complex operates today the difference between profit and loss sometimes hangs in rather a delicate balance. The Alabama State Chamber of Commerce is dedicated to keeping a favorite business climate in Alabama. If a good business climate can tip the balance toward a profit for our industries we will have made Alabama a better place in which to do business.

This simple rationality seems, along with some other social and economic realities, to have escaped our visionary intelligentsia who consider the profit motive an evil thing. Were it not for the earnings and profits of business and industry where would we derive tax to support schools and other necessary governmental functions? What would be the source of funds to support religious and cultural organizations? Can one think of any phase of our lives that does not ultimately depend for its substance on the profitable operation of business and industry?

Profits are the factor that can make the difference between progress and stagnation, between prosperity and poverty for our society as a whole. Profit possibilities are the final determining element in economic expansion.

Our great need today is for educators who teach economics to their students—the business managers, employees, customers and voters of tomorrow—and for businessmen who will truly understand the merits of the system in which we live and raise their voices in its defense. The record expansion of Alabama industry is evidence of our good business climate at present. Let's keep it that way in the future.

The third method of industrial expansion, that of creating new industry from within, is a challenging and sometime richly rewarding venture for both corporate and private enterpreneurs. There are probably more opportunities for new ventures today than ever before, also, capital, both loan and equity, is more available to help finance new ventures. Funds may be obtained from private as well as public agencies.

Many new products and processes are being brought forth by the research and development work sponsored by universities and private concerns. These developments usually evolved a new product or an improved process which is the basis for a new venture. Consider the items that have come on the market as a result of developments in electronics. Scores of new items were made possible by the aerosol can and the squeeze bottle. Our economy is constantly changing as are the tools, implements and gadgets of our daily lives. It has been estimated that some 60 percent of the items being manufactured by American industry now were unknown to the past generation.

Industrial development in Alabama has been successful in attracting industry from other areas and encouraging expansion of the industry operating within the state. We will make every effort to maintain a healthful business climate conducive to the continuing growth and expansion of our Alabama industrial family.

In the matter of creating industry from within we have not taken advantage of our investment opportunities. By no means an isolated example, we find the local super markets have frozen french fried potatoes from Oregon, frozen sweet potatoes from Louisiana, roasting ears of corn and cut okra from Illinois, but no frozen vegetables packed in Alabama. Perhaps in time we will educate and stimulate more of our young people in creating and operating small industries using the resources and markets we have available.

Labor Conditions In The Lumber Industry In Alabama 1880-1914

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The picturesque lumberjack of the north woods was conspicuously absent from the lumber camps of the South. Instead, local farmers constituted the vast majority of the workers in the southern lumber camps and sawmills. Most of the operations were located in areas that were not particularly prosperous agriculturally and in which industry was either scarce or nonexistent. The workers were accustomed to working long hours for a bare subsistence on their own farms, so they were not adverse to working long, hard hours for low pay in the lumber industry. In order to understand this fully, it is necessary to consider briefly the workers' background.

In the 1880's, work patterns in the deep South were still influenced to a large extent by the plantation and social systems of pre-Civil War days. These influences continued, with only gradually diminishing importance, up to the outbreak of World War I. The plantation system developed a managerial class with rather strong paternalistic attitudes toward the workers. While the managers were accustomed to looking out for the basic needs of the workers, they neither sought nor accepted advice from the employees. Nor did the managers brook outside interference in the conduct of their business. The paternal attitude of the owners and managers, plus their resistance to any type of governmental regulation, did much to set the work patterns for the lumber industry.

The workers were also greatly influenced by the pre-Civil War social system. The Negroes were too recently out of slavery to have the capacity for leadership or for any really independent action. They accepted the prevailing work conditions and pay scales, and assumed that there was no way they could alter the condition.

For several decades after the Civil War, a great part of the white population of the deep South lived at a relatively low economic level. Many of the family farms simply did not yield an adequate income. This was due to the poor farming techniques, lack of facilities for marketing products, and the fact that the small farms were usually located in areas of poor soil (1). As a rule, the best timber in the Yellow Pine Belt was found in areas that were poor for agriculture. Thus, in the period 1880-1914 there were large numbers of workers, both white and colored, who were accustomed to a low standard of living.

Another factor affecting the labor situation in the lumber industry was the ration of labor supply to industrial development. It is not possible to estimate this ratio with precision, but a comparison of the population to data on manufacturing output gives a rough idea of the lack of opportunity in many of the southern states for industrial work. For example, the combined population of Alabama and Florida in 1880 was approximately equal to that of the state of Massachusetts. Yet Massachusetts, with its large number of manufacturing establishments, employed nineteen times as many male employees.[1] In most cases, the only industrial work available in the forest areas of Alabama was with the lumber companies, and the hardpressed farmer shifted back and forth between work on the farms and work in the forests and sawmills according to seasonal demands and opportunities for income (4). As the lumber industry grew in importance, it offered more men permanent jobs, and by the turn of the century most of the skilled workers knew no other occupation.

One additional factor in the workers' background should be considered. This was the comparative isolation in which many people of the lower South lived. Life was rural rather than urban in character, which tended to accentuate both economic and social aloofness. Workers were not accustomed to organizing for their own benefit, and even had they wished to do so, their isolation made concerted action difficult. One result of economic isolation was a lack of cash. Much local trade was by barter. The cash scarcity made even a small cash wage seem large. The custom of barter made the script system of the company stores more acceptable.

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[1] Although the combined population of Alabama and Florida in 1880 was approximately the same as that of Massachusetts, the extent of industrialization is hardly comparable, as shown in the following table:

	Alabama and Florida	Massachusetts
Population	1,521,998	1,783,085
Number of manufacturing establishments	2,496	14,352
Capital invested	$12,878,688	$303,806,185
Number of male employees	12,932	228,834
Annual wages	$ 3,771,379	$128,315,362
Value of products	$19,111,942	$631,135,284

Report on the Manufacturers of the United States at the Tenth Census (June 1, 1880) Embracing General Statistics and Monographs, p. 5, Washington, 1883.

In summing up the workers' background, it will be seen that a large supply of labor in relation to available non-farm jobs, a standard of living much below those prevailing in other parts of the country, a relatively isolated communal life, and a lack of ready cash were of major importance in determining the labor situation in the lumber industry. Added to this was the paternalistic and laissez-faire attitudes of the owners and managers.

Any discussion of working conditions in lumber and logging industries must take into consideration the fact that the mills and the lumber camps before 1914 were almost invariably considered temporary affairs. It was not thought possible to have permanent operations. Logging and sawmill operations lasted as long as the supply of raw material lasted; then operations were transferred to a new area. Since work in one area was of a temporary nature, it was not considered necessary or even feasible to erect churches or schools, or even comfortable quarters for the workers. Camps and mills were often located in isolated areas where recreational facilities of any type were lacking. Most of the workers, however, were not accustomed to much in the way of recreation and looked upon the temporary nature of the work and the isolated locations as necessary evils, somewhat in the manner that a miner becomes reconciled to working underground.

Work in the lumber industry, however, was not considered a bad type of work. In fact, it was often sought after and only occasionally was there a shortage of workers up to the time of World War I. In addition to offering almost the only source of cash income in certain sections of Alabama and West Florida, work in the lumber industry offered a certain amount of excitement and companionship. The men usually spent their free time lolling around the mill or company store. Little boys would watch the logging trains and impressive sawmill machinery and decide that they wanted to be lumbermen.[2]

In addition to cash income and excitement, working for a big company gave a sense of "belonging." The company store and the company doctor, the company-built houses and the company-financed church were all part of the patterns of life. The managers of the company gave picnics and cane-juice drinking parties for the workers, and often attended the parties themselves in order to hear the Negroes sing. The parties lasted until after midnight, and as Zell Peagler, a Negro worker, expressed it, "We would push the old cane mill and hum. My Lordy, what a day!"[3]

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[2] Interview, Dec. 10, 1957, with Messrs. Mark King and John Bass, retired employees of the W. T. Smith Lumber Company, Chapman, Alabama. Information corroborated by Mr. Julian McGowin, Secretary-Treasurer of the W. T. Smith Lumber Co., and Miss Olive Spann, secretary to the president of the same company.

The paternalistic attitude of the managers of one company extended to granting work to their employees even when the mills were closed down. The source of employment during these off periods was the company farm. Large numbers of work animals were used and it was the practice of the company to operate a farm in order to grow feed for the animals. Since almost all the workers had some farming experience, it was natural to employ them on the farm when the mills were closed. The rate of pay was the same for work on the farm as in the mill.[4]

The managers were proud of their labor relations and felt that the good relations were due to their respect for the rights of the laborers. This attitude is well illustrated by an editorial written in 1885 for a lumber trade journal. The writer stated:

"We turn with pride and pleasure from a perusal of the labor trouble and mob violence that attends them, in the North and Northwest, to a contemplation of the calm and peaceful relations that have marked this feature of the social history of the Southern States since the war.

"But the most gratifying feature about the whole wonderful change from 'slave' to 'free labor,' and the wonderful impetus given to manufacturing industries of late years in this war-desolated section, is to be found in the fact that labor has been respected and has received all the compensation that it earned. There has never been, in all these hard years since the war, a single serious strike, or any outrage on the part of the working classes, that originated in any of the Southern States" (7).

A few months later this same journal stated categorically that "practically, labor strikes have given so little satisfaction that they are likely soon to be abandoned altogether. This is a result that sooner or later was to have been expected" (7). Later in the same editorial, the writer's crystal ball became a little clearer and with a certain amount of warmth he wrote:

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[3] Interview on Oct. 26, 1951, of Miss Olive Spann, Secretary to Mr. Floyd McGowin, President of the W. T. Smith Lumber Company with Zell Peagler, a retired Negro employee of the Company. Mr. McGowin, a graduate of Oxford University and a former president of the Alabama Historical Society, encouraged his secretary to interview the old retired employees of the company so as to have a permanent record of their experiences and attitudes. Miss Spann is an experienced stenographer and made verbatim notes of her interviews. Transcripts of these interviews were made available to the author during the week of December 9-13, 1957.

[4] Statement of Messrs. Mark King and John Bass, Dec. 10, 1957. Information corroborated by several officials of the W. T. Smith Lumber Company.

"For, of a certainty, we cannot have in this country two sets of laws, one for the workman and another for the employer.

"The working classes the world over have for some time past been imbibing a number of pernicious doctrines of the communise (sic), which the sooner they discard the better for all concerned, since these doctrines are not only impolitic and wrong but wholly impracticable" (7).

Strikes may not have been effective in the South in the 1880's, but at one time Negro workers resorted to an ingenious method of gaining their point. They simply threatened to move away if their complaints were not heeded. A contemporary newspaper account of this threat stated that:

"This 'exodus,' so called, assumed such immense proportions that the southern whites became really alarmed, and for the first time realized the full extent to which they were dependent upon colored labor, and went seriously and actively to work to prevent the threatened exodus. Meetings were held in almost every county, and the most eloquent speakers among the whites earnestly begged them not to leave their old homes and associations, presented to them the most frightful pictures of the rigors of a Kansas winter, and promised them they should have every right they were entitled to under the laws and customs of the country. The promises were kept, and the exodus was checked and no trouble has arisen since" (7).

This "exodus" was part of the large movement of Negroes begun in the spring of 1879 and soon known as the "negro exodus from the Egypt of the southern states to the Kansas Canaan" (3). The movement had been started in 1871 by "Pap" Singleton, an illiterate but extremely capable Negro from Nashville, Tennessee, as a means of helping Negroes secure their own farms and homes. By the end of the 1870's, the movement had gained a measure of success and much publicity. As a result, a very heavy migration from all the states of the lower South started in 1879 and lasted for almost two years. This sudden migration was a surprise to the white South and even more of a surprise to Kansas. As might be expected of such a sudden and large migration, little preparation was made by the Negroes, and since public opinion in Kansas had become hostile to such a large immigation of Negroes, this later movement was not successful and most of the "exodusters" eventually returned to their old homes in the South (3). The movement, however, showed that the southern Negro workers were not completely docile in the early 1880's and that they could organize concerted, but nonviolent, action.

ATTEMPTS TO UNIONIZE

Unions had little effect at this time. The workers, both Negro and white, were poorly educated and out of touch with working conditions outside of their immediate area. In addition, the workers were scattered sparsely over a large area, making concerted action very difficult. Working conditions and pay scales seemed to be acts of God over which the workers themselves had little or no control.

Union activity in the lumber industry was just getting started in the South before World War I. The first union to be successful in the lumbering industry in the South was the Brotherhood of Timber Workers, which was organized in Louisiana in 1910. In 1912 this union joined the Industrial Workers of the World and exerted some influence in Louisiana politics for a few years (8). In fact, what success the Socialists had in Louisiana at this time was the result of alliance between the small farmers and the lumber workers (10).

There was little union activity in Alabama and West Florida until after 1914. An interesting exception was the action of the Knights of Labor at Brewton, Alabama, soon after the turn of the century. This union was trying to organize the Harold Mill Company and threatened to call a strike. George C. Harold, the owner, was a German immigrant who apparently had strong ideas about being dictated to by labor unions.[5] He told his men that if they struck, he would close the mill. They struck, and he kept his word. Harold simply locked up the mill and retired. At the time he had about 200 or more employees. Later the entire operation was sold to T. G. Atkinson of Green Bay, Wisconsin, but the mill was never again operated.[6]

Probably more typical was the action of the Kaul Lumber Company. About 1908 the manager of the Tuscaloosa plant noticed that the men were holding meetings behind one of the mills. He assigned an undercover Pinkerton agent to attend a meeting, found out one worker was trying to organize a union, and simply fired the worker. Later the machinists did join a union and when John L. Kaul, the president of the company, heard the news, he said it was all right for them to join, but for them to remember that he was still going to run the company.[7]

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[5] When Mr. Harold first came to this country he spelled his name Herauldt.

[6] Letter from Mr. Ed Leigh McMillan, President of the T. R. Miller Company, Brewton, Alabama, to Richard W. Massey, Jr., dated June 17, 1958.

In other parts of the South, the lumber companies opposed the unions even more vigorously, resorting to lockouts, discrimination, breaking up of union meetings by force, and blacklisting. After a strike in 1912, the American Lumber Company of Merryville, Louisiana, discharged all militant unionists, and by placing them on a black list, prevented them from receiving employment with other companies. Some 5,000 members of the Brotherhood of Timber Workers had been blacklisted by 1916 and could not find employment in the South because the various mill owners cooperated through their associations in denying work to these men (8). The back of the union movement was broken, and the lumber industry in the South was not unionized until considerably later.

The opposition to unions was immediate and vigorous, but this did not necessarily mean that the owners and managers held human welfare in disdain. Most lumbermen pursued policies that they felt were best for all concerned. They took a paternalistic attitude toward their workers, and since the companies were usually operating on a narrow profit margin, they felt that any substantial increase in the cost of labor would simply throw the companies into bankruptcy and the employees out of work. Their attitudes were general throughout the business world at that time. Law and custom did not require the employer to grant recognition to the unions, while it did give him the right to suppress unions if he could.

PAY AND WORKING CONDITIONS

Low pay and poor working conditions were not peculiar to the lumber industry. Most workers in the South before 1914 worked long hours for low pay. For example, an ordinary printed time book for the year 1905, the type of book that was sold by all stationery stores, had a printed table of wages in the front for the convenience of payroll clerks in figuring pay. The table was based on a ten-hour day and a six-day week. Tables were given for rates of pay from one dollar to fifteen dollars per week (9). It can be presumed that these were the popular pay scales for the period. The payroll records of the W. T. Smith Lumber Company bear this out. The record for January, 1897, lists daily wages from a maximum of $2.00 for foremen and $1.50 for sawyers to 80¢ for the average worker and 25¢ for water boys.[8] These rates, however, compare very favorably with those paid at the time by the Shelby Iron Company of Shelby County, Alabama.[9]

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[7] Interview with Mr. J. H. Eddy, Manager of the Kaul Lumber Company, June 24, 1959.

Apparently the most severe complaint of the lumber workers was not the rate of pay, but the fact that so often they did not receive their pay in cash. Instead they were given credit at the company store. This practice was fairly common until about 1900.[10]

By the turn of the century, most workers had solved the problem of receiving their pay in cash, but they were still faced with the ever-present danger of accidental injury or death. Work in the lumber industry is considered fairly dangerous work even today. This is true despite the fact that the industry and the insurance companies have been stressing safety and encouraging safety programs since shortly after World War I (2).

In the early period of lumbering, there were few safety devices and little thought given to safety engineering. Men faced the hazards of their employment as part of the job. In fact, before the enactment of workmen's compensation laws in Alabama in 1920, the employer assumed little responsibility for the safety of his em-

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[8] Pay Roll records of the W. T. Smith Lumber Company for January, 1897. Located in Alabama State Archives. Exact pay scales were as follows:

Saw Mill		Water Boy	.25
Foreman	$2.00	Riftsaw	1.00
Sawyer	1.50	Edger Feed	.80
Asst. Head Block	.80	Edger Offbearer	.80
Bull Wheel	.80	Extra	.80
Ramp	.80	*Little Furnaces*	
Offbearer	.80	Fireman	1.00
Fireman	1.25	Fuelman	.80
Trimmerman	.80	*Train Crew*	
Stacker	1.60	Engineer	2.00
Butt Saw	.80	Fireman	1.25
Oiler	.80	Brakeman	1.00

[9] Pay Roll Records, Shelby Iron Company, April 5, 1893. Library, University of Alabama. In 1889 Colonel A. M. Shook, a Birmingham, Alabama, industrialist visited England and was quoted as saying that the iron and steel workers in Alabama were receiving pay 50 to 75 per cent higher than similar workers in England. He found the average iron and steel workers in England received eighty-seven cents per day, with only a few workers making as much as one dollar per day. *Southern Lumberman*, Dec. 15, p. 10.

[10] Spann interview with John Perdue, April 11, 1952.

ployees. The common law defenses known as the "fellow employee rule," "the doctrine of contributory negligence," and "the doctrine of the assumption of risks of the industry" usually protected the employers against claims by employees for personal injury (6).

The labor situation in Alabama before World War I was complicated by the use of convicts in private industry and by the use of recent immigrants secured on a contract basis from employment agents in the seaboard cities of the East.[11]

For many years after the Civil War, it was the feeling of the taxpayers in the South that the prisons ought to be self-supporting. One way to accomplish this was to authorize the leasing of prisoners for work outside of the penitentiary. Until the abolition of lease systems in Alabama in 1928, the majority of the convicts leased from the state worked for the Tennessee Coal, Iron and Railroad Company in their coal and ore mines (5). During the period 1910-1914, however, some 300 convicts were used in sawmills in Alabama (5). Convict labor was never very satisfactory from the standpoint of the mill owners because of the cost of guarding the prisoners and the fact that sawmill operations were often seasonal.

Another labor experiment that proved to be even less satisfactory than convict labor was the use by the lumber companies of immigrant labor secured on a contract basis from labor agents in the East. One company which tried this type of labor was the Kaul Lumber Company which used several score of Italian workers in their operations near Tuscaloosa in 1906-07. The company paid the railroad fares for the men to Alabama, and this amount was later deducted from their wages. As a whole, the arrangements turned out quite unsatisfactorily. The men were not accustomed to such sustained and strenuous work as logging and simply could not do the work as efficiently as the local Negro and white laborers. Also, the Italians missed their customary diet, including wine. It was difficult to get good cheap wine in Alabama and although the labor boss tried to bring wine in from New Orleans the laborers were never satisfied. After this first experiment, the Kaul Lumber Company did not renew the contract.[12]

The experience of the Jackson Lumber Company of Lockhart, Alabama, with contract labor was even less satisfactory. This company got into considerable difficulty with the Federal Government over the question of peonage.[13]

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[11] Interview with Mr. James H. Eddy, January 15, 1958. Elizabeth Boner Clark, "The Abolition of the Convict Lease System in Alabama, 1913-1928." Unpublished master's thesis, University of Alabama, 1949.

[12] Interview with Mr. James H. Eddy, January 15, 1958.

Actually in the period 1880-1914 there was never a need for the lumber operators to look beyond the local labor market. The native laborers were hard working, and intelligent and skilled enough for the work at hand. They did an excellent job of exploiting the virgin forests, primarily for the benefit of absentee owners (11).

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[13] See "Peonage in Alabama," *Outlook*, LXXIV (June 13, 1903), 687-88; (July 18, 1903), 732-34; (August 8, 1903), 890-91; "Slavery in the South Today," *Cosmopolitan*, XVII (March, 1907), 481-91; "Peonage in the United States," *Nineteenth Century*, LXII (August, 1907), 306-22; *Pensacola Journal*, December 9, 1906.

The Economic Impact That Florence State College Had On The Surrounding Community During A Given Period Of Time

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A college has teaching as its primary purpose of existence. As a result of accomplishing this purpose an academic, cultural, and service contribution is rendered the community in which the institution is located. However, a secondary benefit is also rendered which many people never recognize. This benefit is an economic one and arises out of the academic program, the current operating budget, and the annual capital expenditures of the institution. More specifically, the immedate economic impact is caused by the expenditures of students, the employees, the institution, and the organizations on campus whose existence depends upon the college.

The primary purpose of this study was to obtain an approximate quantitative measure of the economic impact that Florence State College had during a given period of time on the community in which it was located. The community was an area arbitrarily defined as twenty miles in any direction from the city limits of the Quad-cities, which is comprised of the cities of Florence, Sheffield, Tuscumbia, and Muscles Shoals, Alabama. The time period selected was the 1963-64 school year.

Expenditure questionnaires, financial reports, and personal interviews were utilized to obtain the necessary data from which to measure the impact created by the college.

Data from which student spending was measured was obtained by the use of a questionnaire. A 10 percent random sample of the student population of the spring semester of the 1963-64 school year was taken and a 95 percent return yielded the following results concerning the source, nature and amount of student spending:

Fifty-seven percent of the respondents declared that they kept either a written budget or approximate amounts of their expenditures. Freshmen and sophomores were the more lax in their bookkeeping.

The primary sources of student income in order of importance were found to be families of the students, student savings, and student jobs.

Approximately 40 percent of the respondents declared that they had purchased a durable good during the school year that cost $100 or more.

Twenty-six percent of the respondents said that they had purchased an automobile during the previous year. It is interesting to note that as of January 1, 1965, the Office of the Dean of Men at Florence State College had issued over 2,000 automobile decals to a student body of approximately 2,400 students. Six hundred of these decals were issued to dormitory students.

Information from the respondents indicated that, not including tuition, housing, food and books, the average Florence State College student spent approximately $100 per month for goods and services while attending college. However, the respondents declared that only $50 of this amount was spent in the local community.

Assuming a ten month school year and using the 1963-64 Florence State College enrollment, we may conclude that Florence State College students spent approximately $868,300 in the Quad-cities area during the school year. Based on the local and state sales tax rate, which is 4 percent state and 1½ percent local, an estimated $47,750 was paid by Florence State College students for sales taxes during the school year.

Data from which the Florence State College employee contributions were measured was also obtained by the use of an expenditure questionnaire. A census of the 230 full-time employees of the institution was taken. The employees were classified as faculty, staff, and maintenance personnel. The maintenance classification included janitors, maintenance workers, and building and grounds employees. Of the 230 expenditure questionnaires that were sent, 67 percent were returned completed.

Of the faculty responding, 74 per cent said that they came to the Quad-cities as a result of obtaining employment at Florence State College. This professional group brought 152 dependents into the community.

Of the staff responding to the questionnaire, 39 percent said that they had moved into the community as a result of employment by the college. This group brought 22 dependents into the community.

Of the maintenance personnel responding, only one said that he had moved into the community as a result of employment by the institution. This employee brought 3 dependents into the community.

An analysis of property ownership of the total employee group indicated that 38 percent rented and 62 percent owned their homes. The group that rented said that they paid approximately $87,800 annually for rent. Of the group that owned their homes, 33 percent said that they had either built or purchased new; 28 percent said that they had purchased from the previous owner. New capital formation attributable to the employee group was found to be approximately $1,000,000; however, this capital formation occurred over a period of years. An analysis of the tax records of the counties and cities located in the local area revealed that Florence State College employees paid a total of $13,692 in real and personal property taxes for the 1962-63 fiscal tax year.

The total payroll for Florence State College in 1963-64 amounted to $1,208,946. It may be assumed that most of this income was spent in the local community.

In order to obtain data concerning institutional spending, an analysis was made of the 1963-64 Florence State College annual budget and a personal interview was held with the College Treasurer.

An analysis of expenditures by Florence State College for the fiscal school year of 1963-64 yielded the following information:

The total expenditures for operations by the College for the period amounted to $2,049,799, itemized by percentage of the total as follows: administration, 11.9 percent; instruction, 44.3 percent; library, 4.4 percent; operation and maintenance of plant, 10.6 percent; debt service, .01 percent; other budgetary expenditures, 1.3 percent; self-supporting interprises, 26.9 percent; and fixed charges, .6 percent.

As evidenced by the nature of the expenditures for operations, a conclusion may be drawn that most of the expenditures for operations by the college were spent locally.

The total capacity outlay by the college for the school year amounted to $459,000. Of this amount, $417,000 was spent for new buildings, $20,000 was spent for alterations of buildings, and $22,000 was spent for new equipment. Although it was not possible to obtain estimates from the contractors showing the allocation of the costs of construction for the new buildings, the contracts that were let specified that whenever possible labor would be obtained from the Quad-cities labor market. As a result of this provision in the contracts a large number of jobs were created for workers in the community.

A personal interview with Mr. B. N. Tomlinson, Assistant Director of Redevelopment for the Florence Housing Authority, indicated that approximately $125,000 was spent during the 1963-64 school year in connection with the redevelopment program now in operation in Florence, Alabama. This spending by the redevelopment program was directly attributable to the college.

Other organizations on the Florence State College campus whose impact would be attributable to the college included the U.S. Army Reserve Officer Training Corps, the cafeteria, which is leased to the Slater Food Service, and the two church affiliated groups, which are the Baptist Student Union and the Wesley Foundation. Expenditure questionnaires and personal interviews were used to gather data from these organizations.

The economic impact created by the U.S. Army Reserve Officer Training Corps upon the community was realized through the annual expenditures for operations, payments to students for participation in the program, and spending by the Reserve Officer Training Corps personnel.

Annual expenditures for operations by the Reserve Officer Training Corps for the 1963-64 school year amounted to $6,500. An examination of the Supply Records of the unit revealed that all of these expenditures were made in the local community.

An analysis of the U.S. Army Payroll Vouchers on file in the local unit revealed that approximately $20,000 was paid to Florence State College students during the school year for participation in the advanced program.

During the 1963-64 school year the Florence State College Reserve Officer Training Corps unit consisted of 5 officers, 7 enlisted men, and one department of the Army civilian. The annual payroll for these personnel during the 1963-64 school year amounted to approximately $94,000. This amount included total salaries plus living expenses and per diem. Because of the distance to the nearest military installation it is assumed that the majority of the Reserve Officer Training Corps Payroll was spent locally.

The spending by the Reserve Officer Training Corps was of particular importance to the Quad-cities area because the money constituted a new injection into the local community.

Only two of the Reserve Officer Training Corps personnel indicated that they owned their homes. And this ownership constituted a transfer rather than any new capital formation.

A personal interview with the director of the Slater Food Service revealed that during the 1963-64 school year the Cafeteria spent $131,350 for food. Of this amount, $58,210 was spent in the local community.

The cafeteria payroll for the school year, not including student payroll, amounted to approximately $36,700.

Completed expenditure questionnaires from the two church affiliated groups on campus revealed that a total of $17,700 was spent during the school year by these organizations. Of this amount, $12,700 was for salaries and $5,000 was for operations.

This study did not include the additional economic contribution made by parents, alumni and visitors who came into the local area for various reasons associated with the college. Nor did it measure the ever increasing economic contribution through increased productivity and earnings made by Florence State College graduates who remained in the community after graduation. It is interesting to note that this group comprised approximately 20 percent of the year's graduates.

Of the spending that was measured, however, approximately $3,700,000 could be attributed directly to the College. Therefore, a conclusion may be drawn that Florence State College, in terms of total spending, made a substantial contribution to the community during the 1963-64 school year.[1]

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[1] An unknown mulitplier effect would give the spending attributable to the college more impact than is considered in this study.

Some Economic Considerations In Forecasting Telephone Growth And Development

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There is no business in which long-range planning is any more important than in the telephone business. This statement stems from two basic facts. First, telephone facilities, such as pole routes, cables, and central-office switching equipment require a tremendous investment not only to produce, but also to install. And once installed they are committed beyond recovery. As an example of this you can readily see that it is not feasible to consider the removal of cable, once it is buried in the ground, from one location to another. Also when facilities are installed they must have the capacity to serve not just one individual, but all potential customers within the specific geographic area encompassed. They must provide for the future as well as the present. Thus, if we err in our forecasting, we may either spend money unnecessarily if we overestimate the market potential or we may find ourselves in trouble with the public if we do not have adequate facilities to serve them.

The second fact that makes long-range planning so important in the telephone industry is that the investment/revenue ratio of the telephone business is almost inversely proportionate to that of business in general. The telephone business uses the rule of thumb that $2.50 in capital is required to produce $1.00 a year in revenue as compared with industrials, which require an investment of only 50 cents for each dollar of sales.

There are two primary forecasting elements which must be looked at in projections of future growth — population and economic development.

Population projection involves such items as geographic density, over-all size, age composition, growth, number of family units, size of family units, and birth, death, and migration rates. Also there must be a close analysis of existing economic development to determine the influence on birth rates and also to determine whether migration in the near future will be an influx into or a departure from an area. By projecting these last two factors the analyst can establish population trends.

However, the trend forecasting of the future economic development of an area is a more complicated factor. Here is the key to the future per capita income of the people of an area, which determines what part of the future population will be in our market. Or, to re-phrase this, population projection times the percent forecasted to be in the market gives the gross market to be planned for in the future. This drives directly to the heart of our biggest forecasting problem—development of highly accurate long-range forecasts of economic development for specific locations. During the past two decades, forecasts of population growth have proven basically accurate, both in our over-all Alabama area and in specific locations within the State. But, during the same period, our estimates of economic growth and its effect on per capita income have been most difficult to make. Apologies need not be made on this score because there has been a radical change in Alabama's economy—much less the individual area changes, such as have happened in the Huntsville and Decatur areas in our State.

To re-emphasize the effect of changes upon our market for basic telephone service, let me state now that our primary market for basic service is the family unit. To show the impact of economic growth (as expressed for example in increase of per capita income) the following statistics are of considerable interest:

- In 1940 only three out of twenty households in Alabama had telephone service.
- By 1950 almost ten out of twenty families had telephone service.
- By 1964, last year, over fourteen out of twenty families had telephone service.

A graphic glimpse of the changes which have taken place in Alabama's economy can be found in the recent publication of the Alabama Business Research Council entitled "Transition in Alabama—Alabama's Changing Markets." The Alabama Business Research Council, an organization sponsored by private industry throughout the State, instituted this study which reveals the following highlights regarding the increase in per capita income in Alabama:

- In 1939, Alabama's per capita income was only $250.
- By 1963 it had risen to $1,660.
- During this twenty-four year period, Alabama's per capita income increased over 560 percent, while the nation gained only 340 percent.

Granted, our per capita income is still only about 70 percent of the National average, but Alabama is fast closing the gap.

Regarding industrial development, from 1939 to 1963 Alabama's manufacturing employment almost doubled, what with over 1,800 new manufacturing plants being added during this period.

Alabama's farm labor conversely declined by 65 percent during the same period of time, while non-manufacturing employment more than doubled.

Concurrent with all of the above changes in the market was an increasing shift of workers from farm to factory jobs. We have been witnessing a flight from the soil in Alabama, even though farm cash income has increased 5½ times since 1939 in spite of only a third as many individuals dependent on this income.

The findings of the Alabama Business Research Council show that Alabama has gone through the transition from a rural to an urban state. Some 52 percent of Alabama's population now lives in urban areas.

In the forecasting of telephone development and growth, records of past forecast and actual growth provide trend data from which we can develop patterns, or cycles of growth. The simplest example of telephone forecasting would be a small single central office exchange. In forecasting for our outside plant telephone facilities, such as poles and cables, a telephone exchange is divided into sectors with a separate study being made for each sector. As the distance from the dial central office equipment building increases, the density of population decreases and hence we require fewer facilities than we do close in the urban areas surrounding the central office building. Looking at a specific exchange forecast for outside plant facilities made for one sector, we might find that the percent of telephones to dwellings is expected to increase from 27 to over 44 percent during the next ten years. Some of the resource data indicating why this growth is expected might be such factors as a golf course being planned in the area within the next three years, recreational facilities to be located on a lake back of a new dam, etc.

While the above paragraph emphasizes the factors that go into planning outside plant facilities for one sector of a single central office exchange, the combined economic and population factors of all of the sectors determine the amount of central office switching equipment which is required to serve the exchange. Earlier I mentioned that over fourteen out of every twenty families had telephone service in 1964. We are forecasting that by 1974 approximately seventeen out of every twenty families will have telephone service. Thus you can see that, while we are continuing to predict a steady growth in the population factor of our simplified two-part equation, we are also forecasting a continuing growth in per capita income for Alabama.

Applications Of The Deductible In Planning An Individual's Insurance Program

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Deductibles are used a great deal in insuring property, particularly in connection with small losses of high frequency. Through the use of a deductible, the insured assumes the risk for smaller losses, but provides himself with coverage for larger losses which may occur.

"Deductibles help to distinguish maintenance costs from fortuitous losses, save the disproportionate expense of handling small losses, encourage the insured to use care, and make for application of premium to insurance against the more serious losses."[1] In a balanced insurance program the use of deductibles will save premium dollars each year, or the savings can very well be used to increase the amount of insurance, either as to perils or values.

An important effect of the use of deductibles is a reduction in the cost of insurance protection for the larger losses.[2] A deductible clause included in an insurance policy provides that the insurance company will be liable only for the amount of loss in excess of a specified amount. Coverage provided by certain types of policies and the application of the deductible clause to these policies to provide a more balanced insurance program or more insurance to value is illustrated in the following examples.

Often a small additional premium will purchase a rather large amount of additional coverage. Automobile liability insurance coverage is a good example, as illustrated in Table 1. As determined from this table, a 10 percent increase in premium will raise the bodily injury liability limit per accident from $10,000 to $30,000. A 26 percent increase in premium will raise the same $10,000 limit to $300,000 per accident.

A 10 percent increase in premium will raise the liability limit per person from $5,000 to $10,000. To increase both the limit per person and the limit per accident from $5/10,000 to $10/20,000 would require a 20 percent increase in premium, and an increase in premium amounting to 54 percent would result in $100/300,000 limits.

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[1] Albert H. Mowbray and Ralph H. Blanchard, *Insurance: Its Theory and Practice in the United States* (fifth edition: New York: McGraw-Hill Book Company, Inc., 1961), p. 148.

[2] William H. Rodda, *Fire and Property Insurance* (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1956), p. 9.

TABLE 1. Bodily Injury Increased Limits[a]

Limit Per Accident[b]	Limit Per Person[b]													
	5	7.5	10	15	20	25	30	40	50	100	150	200	250	300
	%	%	%											
10	100	107	110	%										
15	106	114	117	121	%									
20	108	117	120	124	127	%								
25	109	118	121	126	129	130	%							
30	110	119	122	128	131	132	133							
35	111	120	123	129	132	133	134	%						
40	112	121	124	130	133	134	135	136						
45	113	122	125	131	134	135	136	137	%					
50	114	123	126	132	135	136	137	138	139					
70	116	125	128	134	137	139	140	141	142	%				
100	119	128	131	137	140	142	143	144	145	147	%			
150	121	130	133	139	142	144	145	146	147	149	151	%		
200	123	132	135	141	144	146	147	148	149	151	153	155	%	
250	125	134	137	143	146	148	149	150	151	153	155	157	158	%
300	126	135	138	144	147	149	150	151	152	154	156	158	159	160

Source: Increased Limits Table 1, *Automobile Casualty Manual* (Applicable in all States except Massachusetts and Texas), Rate Section of the *Automobile Casualty Manual*, Reprinted May 1, 1958, Seventh Reprint, p. 6.

[a] This Increased Limits Table is applicable to bodily injury liability insurance for private passenger automobiles and automobiles rated as private passenger automobiles.

[b] Limits in thousands of dollars.

As illustrated by these examples, a very large percentage increase in coverage can result from a small percentage increase in premium. Under certain circumstances, a deductible is available to apply to bodily injury liability coverage.[3] These examples are not to illustrate the use of the deductible, but to show how a small amount of premium can provide additional coverage.

With respect to automobile physical damage liability, the percentages for increased limits are shown in Table 2. For property damage liability coverage, a 10 percent increase in premium will double the amount of coverage to $10,000. There is also a deductible property damage coverage available, under circumstances similar to those for bodily injury liability coverage.[4] This deductible is not of particular interest here since its application would be limited.

It can be determined from these tables and examples that a

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[3] This form is available provided the company insures five or more automobiles owned by or under the control of the insured. The minimum deductible is $100 and the deductible amount applies to the loss portion of the claim and not to the expense incurred by the company. *Automobile Casualty Manual* (New York: National Bureau of Casualty Underwriters, Reprinted pages), General Rules Section, p. 1.

[4] *Automobile Casualty Manual,* General Rules Section, p. 2.

TABLE 2. Property Damage Liability Increased Limits[a]

$ 5,000	100%	$30,000	121%	$ 60,000	126%
10,000	110	35,000	122	70,000	127
15,000	115	40,000	123	80,000	128
20,000	118	45,000	124	90,000	129
25,000	120	50,000	125	100,000	130

Source: Increased Limits Table 1, *Automobile Casualty Manual,* Rate Section of the *Automobile Casualty Manual,* Reprinted April 17, 1957, Original Printing, p. 16.

[a]This table is applicable to property damage liability insurance for private passenger automobiles and automobiles rated as private passenger automobiles.

small increase in premium can provide a large increase in coverage. This is of particular interest to the agent and the insured in planning insurance coverage to meet the needs of the insured. Assume that a bodily injury state rate (the applicable rate for a particular state) is $20 for a certain classification and territory. This would be for the standard $5/10,000 limits. An additional $4 a year would provide $10/20,000 limits; $4.80 would provide $10/40,000 limits; and $9 additional premium a year would provide $50/100,000 limits.

Such an increase in limits of liability is similar for property damage liability. Assume the property damage liability rate for the standard limit of $5,000 is $13 a year. For an additional $1.30 the limit can be increased to $10,000.[5]

Thus far only the purchase of additional coverage has been discussed. It is generally agreed that, for most individuals, the standard limits of liability coverage are not sufficient. This is partly a result of larger actual losses, publicity of great amounts for damages being sought by claimants (even though the recovery may be small) and large settlements which are often paid to obtain a release for the insured. In order to meet this need for increased limits of liability enough premium can usually be saved on the automobile physical damage premium, through the application of a deductible or of a larger deductible, to compensate for the additional liability coverage. Assume that the insured owns an automobile which had an original F.O.B. list price of about $2,601 to $2,750 (Symbol K).

Assume that the rate for $50 deductible collision coverage is, for an automobile of the current model year (Age Group 1), $61 annually. In comparison, the annual premium for $100 deductible collision coverage is $37, which is $24 a year less premium. The insured would pay $24 a year for $50 coverage! This would only cover loss as a result of collision or upset.[6]

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[5]Illustrations are for Class 1 example only. Rates vary within a state according to classification, territory, and company.

Further examination shows that, assuming the value of the automobile is $2,700 and using the $100 deductible, $2,600 coverage costs $37, or about $1.42 per $100 of insurance coverage. Using the $50 deductible, $2,650 coverage costs $61, or about $2.31 per $100 coverage.

Other deductible amounts are generally available for automobile collision coverage, but the $50 and $100 deductible amounts are sufficient for this example. It is assumed that most insureds would have some deductible amount applying to collision coverage. If the same actual rates in the above example are used, full coverage would cost four times the $50 deductible premium, or $244 a year!

This difference in premium for the $100 deductible in comparison with the $50 deductible coverage (and even larger differences in amount of premium for larger deductible amounts) produces a sufficient amount to pay for additional premium to increase both the bodily injury and property damage liability coverage to give the insured sufficient coverage in accordance with his needs and situation.

Another application of the deductible clause is in the Homeowners policy. To illustrate, assume that Form 2, the Broad Form, has a three year premium of $138 with Clause No. 1 and Clause No. 2 applying and with Dwelling Coverage (Coverage A) of $13,500. If Loss Deductible Clause No. 1 applies,[7] there would be an additional premium of $34 to delete Clause No. 2, enough premium to increase coverage on the dwelling to $15,000 (and also increase coverage on appurtenant private structures, unscheduled personal property, and additional living expense), increase the personal liability coverage from $25,000 to $50,000, and still have a difference of $13 to apply to other coverage. An additional $5,000 coverage on the dwelling (in addition to the $13,500 amount) can be obtained for only $2 more than the difference in premium without the Loss Deductible Clause No. 2, and the premium including that clause, all for excluding $50 of coverage, or less.[8]

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[6] These are actual rates for the $50 and $100 deductible coverage. Rates vary according to the original cost and age of the automobile, in addition to differences in classification.

[7] Loss Deductible Clause No. 1 applies to loss by windstorm or hail. . . . Company shall be liable only when such loss in each occurrence exceeds $50. . . .

[8] When loss is between $50 and $500 the company shall be liable for 111 percent of loss in excess of $50 and when loss is $500 or more, the loss deductible shall not apply.

The inclusion of a deductible clause in the Homeowners policy may allow an insured to elect coverage provided by the Broad Form (Form 2) policy in lieu of that provided by the Standard Form (Form 1). In the above example, the Standard Form policy with $13,500 coverage on the dwelling, Clause No. 2 deleted, three year premium would be $143, which is $5 more than the Broad Form policy with the Loss Deductible Clause No. 2 applying. The Broad Form policy gives more coverage, and probably meets the needs of most individuals somewhat better than the Standard Form. These examples are not given, however, to recommend certain policies, but to emphasize the applications of the deductible clause, making more complete insurance, according to the need, possible for the insured.

Another point to consider, in recommending additional coverage provided by the Homeowners policy, is the extension of coverage which provides for replacement cost.

"If at the time of loss the whole amount of insurance applicable to said building structure for the peril causing the loss is 80 percent or more of the full replacement cost of such building structure, the coverage of this policy applicable to such building structure is extended to include the full cost of repair or replacement (without deduction for depreciation)."[9]

"If at the time of loss the whole amount of insurance applicable to said building structure for the peril causing the loss is less than 80 percent of the full replacement cost of such building structure, this Company's liability for loss under this policy shall not exceed the larger of the following amounts (1) or (2): (1) The actual cash value of that part of the building structure damaged or destroyed; (2) That proportion of the full cost of repair or replacement (without deduction for depreciation) of that part of the building structure damaged or destroyed, which the whole amount of insurance applicable to said building structure for the peril causing the loss bears to 80 percent of the full replacement cost of such building structure."[10]

This replacement cost extension of coverage requires only 80 percent coverage, a must for most Homeowners policyholders. The benefits of replacement cost coverage would, in the event of a large loss, be much more valuable than first dollar coverage (which would already be provided by the disappearing deductible in the event of a large loss).

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[9] Central Forms Committee, MIC-1 (11-59), Extension of Coverage: Replacement cost, 3(b), and MIC-2 (11-59), 4(b).

[10] *Ibid.*, (c).

Other coverage provided by the Homeowners policy can be evaluated according to the insured's needs. The liability coverage for watercraft and swimming pools is of particular interest to those insureds who have this exposure. Extended theft, additional coverage on money and securities, and jewelry coverage can be added to the Homeowners policy by endorsement.

A relatively new development is the combination of the Homeowners policy with term life insurance.[11] Several companies are emphasizing this combination, writing the term life through an affiliated company.[12] An agent can apply this same technique of combination, writing a separate decreasing term ("mortgage protection" or "mortgage redemption") policy along with the Homeowners policy. Often the savings in premium resulting from the use of the deductible clause(s) will be of sufficient amount to pay a portion of the premium for a term life insurance policy.[13]

Another application of the deductible, most often in the form of a waiting period, would be in an accident or accident and sickness policy. The waiting period (or elimination period) may be as short as one day or as long as several years, depending on the type of contract and its purpose.[14]

The many types of policies available to the insured for accident and sickness coverage make direct comparison difficult since each type of policy differs somewhat in the benefits provided. An actual comparison, however, of the same policy with different waiting periods is used in each of the following examples.

A disability income policy, providing benefits for life-time accident and two years sickness (and additional provisions) is used for this comparison.[15] The waiting periods and premium are as follows:

Waiting	Accident	0 Days	14 Days	30 Days
Periods	Sickness	7 Days	14 Days	30 Days
Premium		$63.99	$56.73	$49.55

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[11] "Life Plans Added to Homeowners Policy," *The National Underwriter — Life Insurance Edition*, February 1, 1964, p. 15.

[12] Some agents object to this and would hesitate to recommend it. Such life insurance is not programmed to needs generally, thought it has a tendency to fill a need.

[13] This could be an annual premium, a semi-annual, or quarterly premium.

[14] O. D. Dickerson, *Health Insurance* (Homewood, Illinois: Richard D. Irwin, Inc., 1959), p. 97.

[15] Non-Cancellable and Guaranteed Renewable to Age 65, premiums shown for males, issue age 18 to 30, annual premiums per $100 monthly income, participating policy.

There is a difference of $7.26 and $14.44, respectively, for the 14-day and 30-day waiting period. Another company, with similar benefit periods, shows the following differences in premium and waiting periods:[16]

Waiting	Accident	0 Days	14 Days	30 Days	90 Days
Periods	Sickness	7 Days	14 Days	30 Days	90 Days
Premium		$42.00	$35.50	$30.50	$25.00

These comparisons show only the premiums for similar types of policies with respect to benefit period and waiting period. The same principle applies for other types of accident policies with varying benefit periods. No attempt will be made to classify the types of continuation provisions for health insurance policies, but the following illustration presents the application of the waiting period to the most expensive coverage, releasing premium dollars to purchase a policy with a longer benefit period (for sickness).

A disability income policy providing accident benefits for life and sickness benefits to age 65 will have the following premium:[17]

Waiting	Accident	30 Days	90 Days	180 Days
Periods	Sickness	30 Days	90 Days	180 Days
Premium		$63.51	$54.59	$50.65

In contrast, a policy providing only accident income with no waiting period would require a premium of $23.99 a year, including other benefits.[18] A 180-day waiting period for the lifetime accident coverage and sickness coverage to age 65 policy, for $200 monthly income will result in a $25.72 difference in premium, this difference being applied to the purchase of additional coverage.

Depending on the individual's situation, a combination of several policies with varying waiting periods, benefit periods, and continuation provisions may be used to the best advantage. Using the policies previously mentioned, assume a salary continuation for 30 days for the insured.

A waiting period of 180 days could be applied to the most expensive coverage—lifetime accident and sickness to age 65 (noncancellable and guaranteed renewable to age 65). Possibly $200 monthly income could be provided by this policy, and $100 monthly income provided by a lifetime accident and two years sickness contract. The latter policy could have a 30-day waiting period to coincide with the salary-continuation cut-off date. An additional $100 monthly income could be provided, either by the same type of policy or maybe a different contract, depending on the needs and situation confronting the individual.

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[16] Renewable at Option of Company, monthly indemnity for total disability only, premiums increased 10 percent in certain states, non-participating policy.

[17] Non-Cancellable and Guaranteed Renewable to age 65, premiums shown for males, issue age 18 to 25, annual premiums per $100 monthly income, participating policy.

[18] Same as above, issue age 18 to 35, lifetime accident.

The many types of accident and sickness policies available, and the variety of waiting periods that can be applied, give the insured and agent a great deal of flexibility in securing coverage to meet individual needs. The high premium for disability insurance stresses even more the need for careful planning.

The major medical insurance policy usually has a $500 or $750 deductible, although some types of the "comprehensive" major medical policy have deductibles from $25 up. Since the major medical policies are so varied, it would be difficult to offer comparisons and some evaluation of certain contracts; however, it will suffice to say that they do contain a deductible, along with a provision that the insured will pay a certain percentage of charges incurred up to the maximum limits of the policy. It is assumed that both an agent and an insured who recognize and understand the application of the deductible will turn to some type of major medical policy in their insurance planning.

The infinite number of individual situations prevents an exact conclusion or recommendation from being made with reference to the actual application of the deductible and/or deductible clause for "typical" insureds. The examples presented here could be applied to many individual cases, helping to fit one's insurance program to his needs.

Federalism And Environmental Change

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We usually think of the basic character of the American federal system as having been established when the United States constitution was adopted. However, the system has gone through profound change since the Constitution went into effect. Particularly has it changed during the twentieth century as the country has been industrialized, has experienced rapid population growth, and has become more and more involved in world affairs. These environmental factors have resulted in increased pressures for governmental activity which have been much stronger at the central than at the state level. The ultimate effect has been an alteration in the traditional federal-state relationships, involving a major shift in the boundaries which separate the two levels. Expansion in the activities of the central government has been partly in areas not previously occupied by any government, but it has also extended into areas which were formerly understood to fall under the exclusive jurisdiction of the state governments. Review of acts of Congress by the federal courts was during the first several decades of the century a significant barrier to federal expansion. However, this had been greatly diminished in importance by the end of the New Deal era, by which time the courts had abandoned their previously held doctrine that the federal system was a system of separate and equal sovereignties which were to operate within fixed spheres (2).

The change in environmental conditions that has taken place in this century is registered in part in the extensive federal codes which now exist and which regulate such subjects as public utilities, the buying and selling of corporate securities, employer-employee relations and working conditions in industry, the production and marketing of farm products, and race relations. Under the taxing and spending powers of Congress, the central government today not only maintains its own gradually expanding social security system but also supplies a considerable portion of the funds and determines in part the basic policies for welfare and other programs conducted by the state and local governments. Its grants-in-aid to state governments and their local subdivisions, now amounting to over $7 billion annually, are customarily made available for use only on the condition that the aided activities will be administered in accordance with standards determined by federal agencies. Federal inspection of operations and federal auditing of accounts are means of enforcing compliance with the standards as determined.

The magnitude of the federal expansion has stimulated inquiry among students of American government regarding the capacity of federalism to survive in an environment like that of the present-day United States. Isn't it possible that the system will soon be transformed into a unitary state, in fact if not in name? That the end of the system may be fairly near appears to be the opinion of some careful observers of current trends in the country. Indeed, Roscoe Drummond, a distinguished Washington, D.C., newspaper correspondent, stated in 1949 that the federal system no longer existed and could no more be brought back into existence than an apple pie could be put back on the apple tree (1).

I cannot agree that the federal system had ceased to exist by 1949, and cannot agree that it does not exist today. If the federal boundaries have shifted, this does not mean that they have been obliterated. As we have noted, a part of the federal expansion has been in areas not previously occupied by any government, and in areas which were previously occupied by the state governments. These governments are free today to engage in their former activities except where they interfere with the central government in the exercise of its powers.

The question of the future of the federal system is not so easily dismissed. On the one hand, one cannot ignore the powerful forces making for centralization. On the other hand, there are still important factors whose influence is in the opposite direction. These include the safeguards against excessive and unconstitutional uses of power which are built into the structure of the central government. If judicial review has declined in importance as a check on the legislative and executive branches, there are still the checks which operate between these branches. In addition, there are the checks which the state governments exercise through the role which they have in the composition of the federal legislative and executive branches (6). Senators and representatives in Congress and presidential electors are still allotted to states and are chosen in accordance with state law. Federal constitutional amendments, federal legislation, and federal court decisions have placed limits on what the state governments may do in determining the electorates both for members of Congress and for presidential electors. Nevertheless, I don't think it is inappropriate today to speak of the state governments as "constituent and essential parts of the federal government," as James Madison spoke of them (3). The state governments may still exercise a great deal of discretion in drawing election districts and in regulating nomination and election processes. Thus we can usually expect both Congress and the presidency to reflect to a marked degree the political sentiment which predominates at the state capitols. Inevitably this political sentiment will have much to do with the outcome of election contests, both for members of Congress and for presidential electors.

The checks built into the structure of the central government are made meaningful by other factors, including the pluralistic character of American society and the attachment to locality which continues to be strong in some sections of the country. The pluralistic character of American society was considered by Madison to be another major argument for adoption of the United States Constitution. To him it meant that it would be highly improbable that the new government for which the Constitution provided would ever be under the control of a factional group whose members would be motivated by the same interests or passions. So great was the diversity in pursuits and general patterns of life in a republic the size of the United States that the majorities that determined national policies would ever be split into different factions, at least on most important issues (3).

These views of Madison still have validity. If the United States has grown in unity, it still exhibits a high degree of diversity, sufficiently marked to make it extremely improbable that a numerical majority could be formed that would be ready to push the delegated powers of Congress to their uttermost limits. This is well illustrated by our major political parties. Neither of them has shown in this century a significant tendency toward cohesiveness; on the contrary, each of them, in this century, as in the nineteenth century, has been composed of people of the most diverse interests and political views. Far from being tightly organized national parties, they are in reality loose confederations of state and local party organizations. Their national programs are invariably compromise programs arrived at only after long negotiation between competing interest groups.

There are, then, important factors which can still be expected to serve as deterrents to future federal expansion. Doubtless, if the American federal system breaks down or ceases to exist in anything but a name, it will be largely because of the laxity of the state governments in discharging their responsibilties. An oft quoted statement made more than a half century ago by Elihu Root of New York upon accepting election to the United States Senate still has relevance. He declared that if the states were to be preserved and their authority was to be continued the states would have to exercise their powers. "The only way to maintain the powers of government," said Root, "is to govern" (4).

When one studies the history of our federal system during the last several decades, he is inevitably led to the conclusion that much of the federal expansion that has occurred during this period is to be accounted for by the state governments' failure to use effectively powers which they had. Their failure to adopt adequate regulatory measures dealing with local industrial firms and labor relations brought on some of the demands for regulation by the central government. In the fields of welfare, and highway construction and maintenance, where the major responsibility clearly appeared to be theirs, they allowed the initiative to pass largely into the hands of the central government. Thus we have the greatly expanded program of federal grants-in-aid, with its accompanying federal controls over state activities. However, a noticeable change has taken place within the last fifteen years. During this period, state governmental expenditures have increased at approximately the same rate as national expenditures. State governmental expenditures increased from a little over $15 billion in 1950 to approximately $39½ billion in 1963 (5). These figures would seem to suggest that the state governments have taken on new life. They should, therefore, give encouragement to people who wish to see the states preserved as semi-autonomous entities and the American federal system maintained.

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Changing Ojibwa Kinship: Parallels To The Southeastern United States

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The original classification of kinship systems by Morgan in 1871 (13), was followed by many significant studies of kinship. A relatively recent trend has involved an interest in changing kinship systems, and, partly, an interest in the regularity of change under conditions of acculturation.

Morgan's (13) classification of kinship systems demonstrated the existence of identical systems in various parts of the world that cannot be explained by diffusion, for not only is there no evidence, in many cases, to demonstrate historical connection but, as Murdock (14) and Eggan (4, 5, 7) have observed, kinship systems change with regularity and are directly related to other institutions and to ecology.

In a comparative study of some southeastern United States tribes, Eggan (4) concluded that kinship systems of Crow type (i.e., matrilineal and matrilocal, with lineage principle overriding generation) were once widespread, and that they changed in the direction of bilaterality as a consequence of similar acculturative influences. He further suggested, "that we have here a *general* type of change. If so, we might expect other Crow systems, under similar acculturational influences, to undergo a similar series of changes" (4).

In this paper, I shall review more recent studies of the southeastern tribes as they relate to Eggan's hypothesis. The results of this will then, briefly, be compared to changes in the kinship system of the Central Algonkians, which is of the Omaha type, the exact reverse, or "mirror image," of the Crow—i.e., patrilineal and patrilocal. The Ojibwa, with a system of quite different type — i.e., bilateral, but with patrilineal emphasis—will then be examined for the possible similarities in change that they may exhibit.

Spoehr (15, 16, 17, 18) provided additional verification of the existence of Crow-type kinship among the Cherokee, Creek, Choctaw, and Seminole, with a further probability for the Chickasaw. Further, he found a regularity, or order, of change, characteristic of the kinship system of these groups (18). The first shift is to a greater emphasis on patrilineal descent in the classification of Fa Si's[1] descendants. The second shift is from a lineage principle (with overriding of generation) to a generation principle in classifying the descendants of Fa Si and Mo Br, and the extension of sibling terms to both parallel and cross cousins. Mo Si and Fa Si become terminologically classed with Fa Br. "The end product is a system in which the original overriding emphasis on lineage has been discarded for a simple generational scheme" (18).

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[1] Usual anthropological abbreviations for kinship terms are utilized; thus, Fa is Father, Mo is Mother, Fa Si is Father's Sister, etc.

However, the new terms are limited to members of the bilateral family, and the traditional terminology is utilized for members of related clans. The terminological separation of immediate bilateral kin from clan kin parallels the diminshing importance of clanship, for at this time point the clan kinsmen are "courtesy kin." The Fa-in-law's clan, the spouse's clan, the MoFa's clan, and the Fa Fa's clan are set outside the circle of bilateral kinsman. The rise of the bilateral family as the largest functional unit is thus related to the decline of the clan. With the youngest generation, English is coming into common usage, together with the white American kinship terminology.

Spoehr (18) also noted that behavioral change preceded terminological change: the range of kinship contracted after the decline in importance of the clan. While the levirate disappeared as a marriage form, the Si-in-law and, sometimes, the Mo Br Wi, is still terminologically classed as a potential spouse. Matrilocality lost its importance and the bilateral family became important before traditional terminology was lost.

Important factors in initiating cultural change among the southeastern tribes were (1) the white settler who introduced white attitudes and usages through intermarriage, (2) the missionary who established and stimulated formal education on the white pattern, and (3) the government agents who were instrumental in the development of centralized government. The "contact milieu" was a changing one that not only included forced movement from their homelands, but, wherever located, greater reliance upon agriculture as the result of diminishing game resources; the changing Indian-white relationships, sometimes marked by violence; the growing white population; and, finally, the loss of tribal lands that brought about the loss of their "essential social and cultural unity" (18).

The series of changes from an original Crow system to a modern bilateral system, methodologically, is based upon historical records on the one hand, and, on the other, studies of contemporary groups that were exposed in varying intensity and time to the acculturative influences. The methodological approach utilized here, and in each of the subsequent sections is that which Eggan (6) has discussed and termed "the method of controlled comparison."

Spoehr (18) further extended Eggan's hypothesis, and suggested that "similar kinship systems of tribes under similar conditions of contact can be expected to change in similar ways." Callender's (2) recent study of the comparative social structure of the Central Algonkians permits testing of this hypothesis. The basic kinship of the Central Algonkians is of the Omaha type: patrilineal and patrilocal, and in detail the "reverse image" of the Crow. And, indeed, he finds that changing kinship behavior and terminology passes through similar stages: (1) kinship behavior follows traditional form among the oldest people and in the groups least affected by acculturative factors; (2) the kinship system becomes bilateral and assumes a generational configuration, although still separating cross from parallel cousins; and (3) in final stage is scarcely different from white Americans. He notes, too, that with respect to behavior and terminology, that "except for a steadily contracting area of usage, corresponding changes in kinship terminology are less evident" (2).

To the extent that minor differences occur in the order of change, it seems plausible to explain the dissimilarities historically. Southeastern tribes were exposed to acculturative influences over a longer period of time; direct Central Algonkian acculturation began later, but with greater intensity. English has replaced Algonkian dialects before some terminological shifts could be made.

The Ojibwa provide a different type of system in which to study kinship change. They have in historical times inhabited the area now included in Ontario and eastern Manitoba (the Northern Ojibwa), northern Minnesota, Wisconsin and Michigan (the Southwestern Ojibwa), the plains to the west of lakes Winnipeg and Winnebegossis (the Plains Ojibwa), and southern Ontario and adjoining parts of Michigan (the southeastern Ojibwa). The Plains and southeastern Ojibwa are not here considered, since the former first is acculturated to plains Indian culture, and the latter to a sedentary, agricultural way of life.

Legend holds (19) that the Ojibwa came from the East, a position upheld by the ethnohistorical data. The Jesuits found the "proto-Chippewa"[2] at the Sault St. Marie in 1640, and the evidence indicates gradual movement to the West and Southwest. The movement appears to have been due, at least in substantial part, to the search for new areas with fur bearing game for the French (and later English and American) fur trade, as well as for space for an expanding population (9).

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[2] Ojibwa is the most common ethnological term for the group; American writers referring to Ojibwa in the United States often use the popular form, Chippewa.

A hunting, fishing, and gathering people, their social structure was well adapted to environment. Linguistic evidence indicates that a pattern of matrilateral cross cousin marriage combined with patrilocal residence was the rule for the Ojibwa and related groups a millenium before the coming of the Europeans (10). Their distribution over a huge area with differing ecological conditions permits us to see social structural adaptation to the different conditions. Originally occupants of the inhospitable north only, some moved further south to the northern Great Lakes, and eventually into the northern portions of Minnesota, Wisconsin, and Michigan. In these southern regions more abundant game, fish, berries, wild rice, etc., permitted greater concentrations of population, with resultant change in social structure. Eventually an important element in changing social environment was the period of protracted hostility with the Dakota. Following the fur trade, and its important but limited effects, was the period of greater contact with the whites, reaching its climax in the mid-nineteenth century, followed by the reservation period.

In terms of the immediate subject, we may discern the following phases of acculturation: (1) the early fur trade, at first indirect, and limited to a few trade goods, but leading to geographical expansion; (2) a more intense period of trade, in which Indian demands for white men's products increased, leading to a greater dependence upon the white and leading also to geographical expansion; (3) the appearance of white settlers and government officials, and the loss of most of their lands through treaties; and (4) the reservation period, characterized by loss of their remaining tribal lands, with its schools, missionaries, and federal government control. The fourth phase involves the loss of the economic and political base of Ojibwa society.

The fact that change has been greatest in the South and least in the North provides control groups for the study of change. The Pekangekum (3) and Round Lake Bands are almost in the same condition as all were a century or two ago; the Berens River Saulteaux (8) are more affected, but retain much of their "aboriginal" character and social structure. In increasing order of acculturation are the bands of the Rainy River Reservation (11, 12), Red Lake (1), and White Earth. The Wisconsin reservations are, probably, now socially and culturally most similar to those of Red Lake and White Earth.

The northern, and oldest, form of social structure includes small bands, usually of less than 100 individuals, without elaborate organization. The group usually encountered, above the elementary family, consists of two or three families based upon co-residence of brothers, perhaps with their father. The kinship system is bilateral, but with a patrilineal or patrilateral emphasis. Bilateral cross-cousin marriage is practiced. "Totemic groups," or patrilineal, totemic, exogamous clans exist, but have little function beyond controlling marriage and emphasizing the unity of the patrilocal groups already based upon kinship (3).

At Emo, Ontario, one of the Rainy River reservations, Landes (11) found that cross-cousin marriage was proscribed, although there were indications that it was still practiced sporadically in areas to the north. In fact, recent times have seen the spread of the incest prohibition to fourth cousins, irrespective of whether they are cross or parallel cousins. Kinship terminology, however still reflects the existence of cross cousin marriage, but the kinship genealogies indicate a tendency to classify all cousins, both cross and parallel, as equal. In effect the system is becoming generational but is still inclusive of large numbers.

Red Lake appears intermediate between Emo and White Earth. In some genealogies strong evidence of cross-cousin marriage terminology occurs in schedules, but at White Earth there is a tendency to develop terms for affinal relatives—terms that were irrelevant or unnecessary in the old system. The distinction between cross and parallel cousins is, in general, lost or confused, and often cousins are grouped together, although distinguished by sex, under either the term for cross or parallel cousin. Middle aged and younger Ojibwa consider all cousins to be the same, utilizing one of the terms or the English word. Some of the older Ojibwa recognize the termological distinction between cross and parallel cousin, but know of no expected behavioral distinctions. The bilateral kin group now consists of the immediate bilateral family, with clear recognition of the grandparents and their siblings, the children of grandparents, first and second cousins, and the children of first and second cousins. Beyond this, the modern Ojibwa must carefully consider genealogy to determine relationship, and then he will use the white man's term or, more likely, a descriptive term. Only some of the oldest individuals, native speakers of Ojibwa, will remember most of the more or less proper kinship terms for those more distantly related to them, or related in a classificatory way.

At Red Lake and White Earth only traces remain of the old "totemic groups" or clans. In the South, the totemic groups appear to have had hospitality requirements associated with them, probably as the result of larger social groupings and more inter-group contact and co-operation. The older people recognize that hospitality was expected, but in recent times only a few old people from some of the more isolated communities expect it. Most of the middle aged persons know their totems if asked, but the younger people are not aware of their existence.

While the Ojibwa kinship system is in many respects different from that of the southeastern tribes and of the central Algonkians, certain regularities of change may be noted. In the latter groups the Crow and Omaha lineage principle shifts to a patrilineal emphasis and then to a generational system with all cousins equated but differentiated from siblings. In the Ojibwa system the cross and parallel cousins are behaviorally equated, but differentiated from siblings, and the system is seen tending strongly toward generational emphasis.

In all three cases the range of kinship decreases: clan kinsmen tend to be regarded as "courtesy kin," but no specific form of behavior is recognized. As clans and more distant or classificatory kinsmen cease to be recognized, the immediate bilateral family and kin become more important. The smaller kin groups, the behavior, and the terminology are among the last of the social institutions to be affected by acculturation.

Spoehr's hypothesis (18) is confirmed; under similar conditions, kinship systems of broad range and classificatory type tend to change to bilateral systems of narrow range.

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Carburization Of Steel In Liquid Hydrocarbons

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INTRODUCTION

Chemical heat treatment of steel, such as carburizing and nitriding, in different media appears to have had a complete investigation, and is commonly known in industry. The well known carburizing media are solids, molten salts, and gases. A very interesting new method has been investigated. In this new method the metal to be treated is heated by high frequency induction while immersed in a liquid hydrocarbon for carburizing and ammonia water for nitriding (4). The method has several interesting aspects, one of which is penetration of carbon or nitrogen in steel. Carburization can be performed in such reagents as benzene, paraffins, alcohols, and tetra-chlorides. The method could also be used for deposition of metals and semi-conductors on the surface of electrical conductors, including graphite.

This study was limited to methanol at various concentrations with water, temperatures and two different pressures, atmospheric and 760 mm Hg (gage).

MATERIALS AND METHODS

The materials studied were Armco iron and 1018 steel. The specimens were 6 mm in diameter and 64 mm long. Both metals were supplied by Steel Sales Corporation, Chicago, Ill. The methanol was reagent grade 99.7 percent purity.

Heat was provided by a 25KW weltronic R.F. generator.

The tests at atmospheric pressure were carried out by placing the heating coil, 23 mm in diameter with four turns, in an 800 ml glass beaker. (Fig. 1)

Other tests were conducted at a pressure of 760 mm Hg (gage). The 3.79 liter pyrex glass pressure vessel was designed by the authors to withstand the pressure at 100°C. (Fig. 2)

The effect of time at the temperature of 920°C was determined by depth of carbon diffusion into the steel sample during carburization for 3, 6, 12, and 24 minutes in 99.7 percent alcohol. The results are shown in Figure 3. The time was determined by stop clock and measurement was started when the specimen reached temperature. Temperature was determined by an optical pyrometer, and

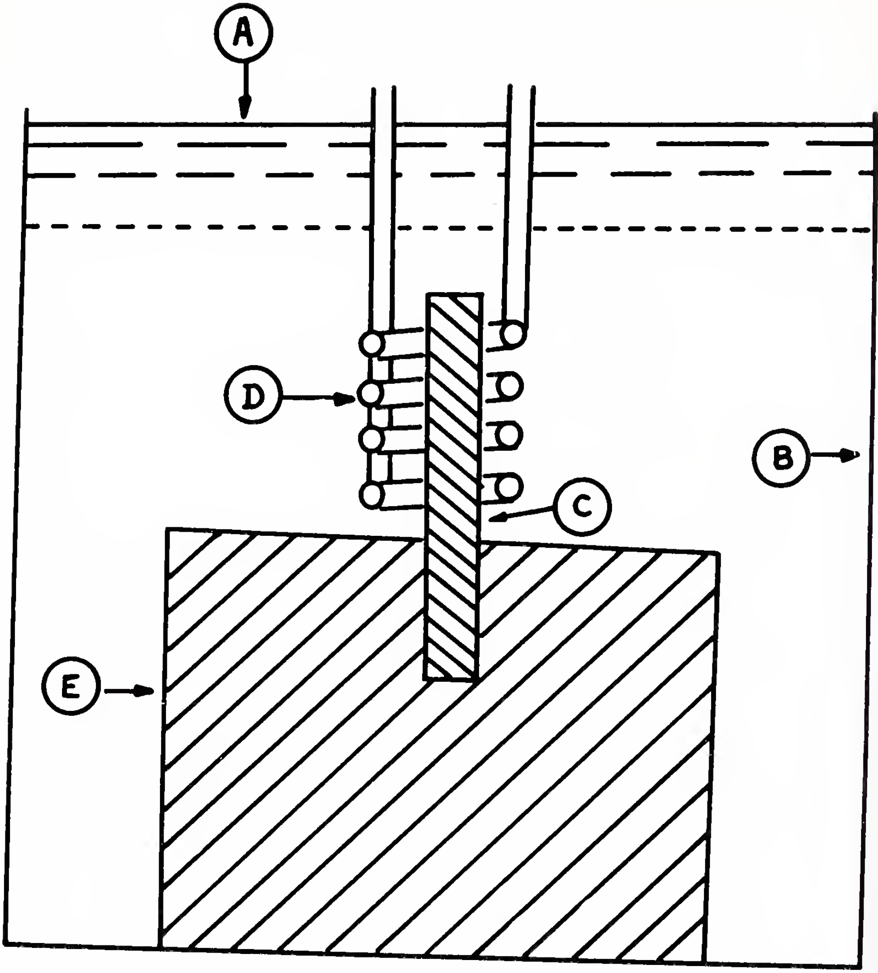

FIGURE 1. Schematic Drawing, Ambient Pressure Testing Apparatus
A = Alcohol
B = 800 ml glass beaker
C = Specimen
D = Coil
E = Fire clay mount

adjusted to the emissivity of carbon. Various concentrations of alcohol in water, 0, 5, 10, 20, 40, and 99.7 percent were investigated at the temperature of 920°C and atmospheric pressure for six minutes. The effect on the carburization of temperatures lower than 920°C (namely 790°C and 760°C) was also investigated for the same period and at the same pressure using 99.7 percent methanol.

The carburized case depth was determined by metallographic examination, where the limit of the case was taken to be the first-evident pearlite.

In determining temperature it was observed that, at the beginning of the test, numerous small bubbles nucleated at the surface of the specimen. These bubbles grew in size and vigor until

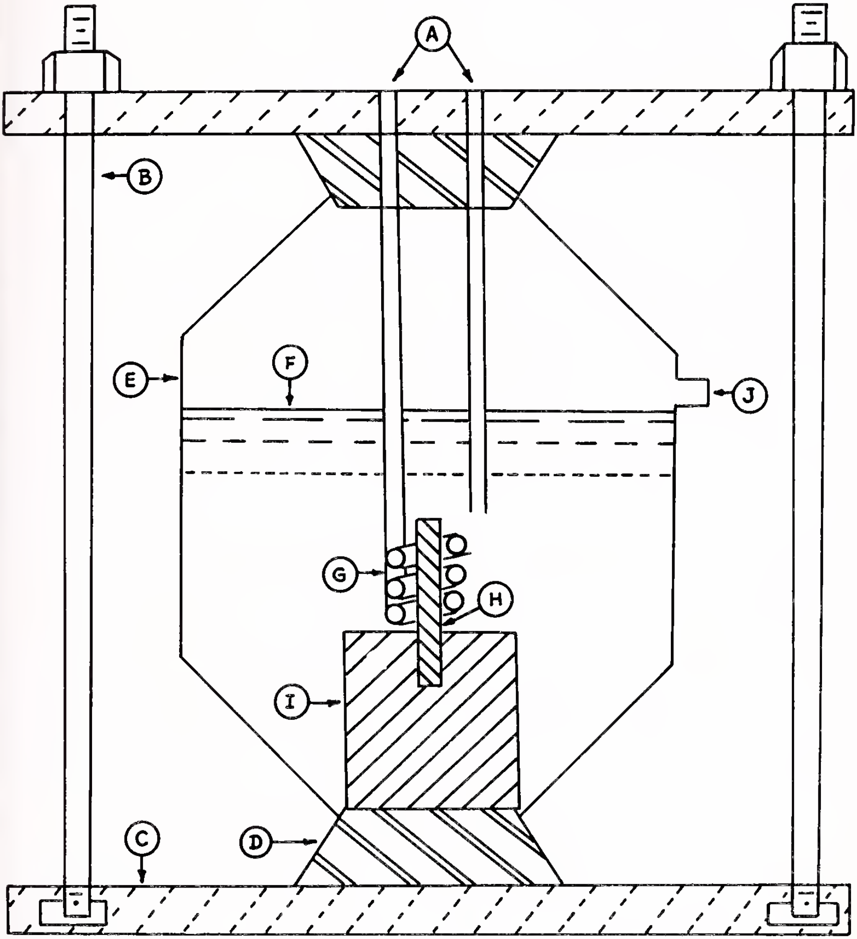

FIGURE 2. Schematic Drawing of Pressure Vessel

A = Coil inlet and outlet
B = Tension bolt
C = Wooden base
D = Rubber stopper
E = Pressure vessel, pyrex glass
F = Alcohol
G = Water cooled copper coil
H = Specimen
I = Fire clay mount
J = To manometer

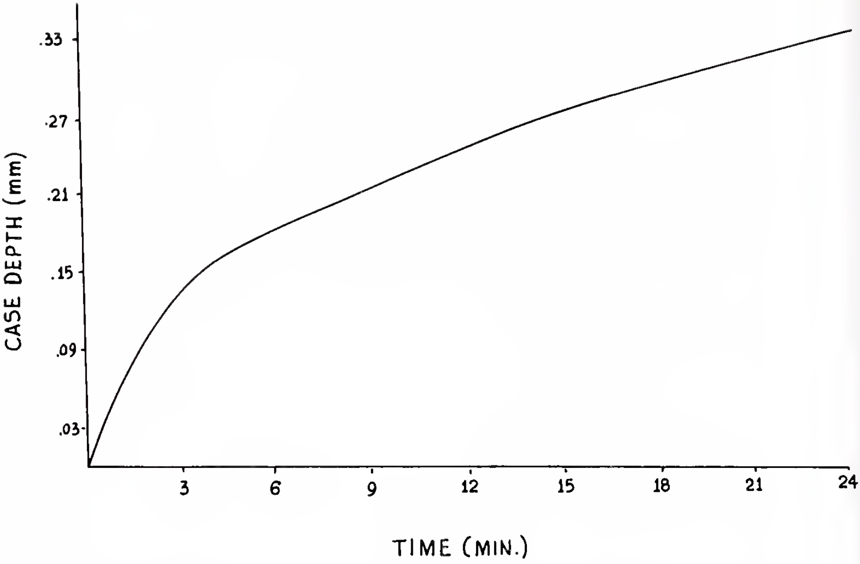

FIGURE 3. Effect of time on case depth in Armco iron, 920°C, 99.7 percent methanol, ambient pressure.

almost instantly a smooth, thin film developed at the surface of the specimen. Temperature could then be measured without bubble interference. This phenomenon will be discussed in the next section.

RESULTS AND DISCUSSION

Increased pressure and increased concentration of alcohol in the carburizing mixture of alcohol in water led to the development of hyper-eutectoid composition in the case. It would thus be indicated that higher pressures would produce higher carbon concentrations in the case.

The concept of increased pressure of the carburizing medium could be used to produce hard surfaces of high carbide concentration on tool steels which have carbide forming alloying elements such as W, Ti, Mo, and Ta.

One of the most interesting phenomena observed during carburization was a smooth, transparent, and very adherent film of vapor that developed at the surface of the metal. This film provided a uniform carburizing medium which would not have been achieved by random bubbles. This type of boiling has been described by Westwater (7). He has also determined the quantity of heat transferred from hot metal to boiling methanol for this and two other stages of boiling, nucleation and transition, and presented the results graphically (Fig. 4).

For investigated temperatures below 800°C it was found that the maximum point (B) on Westwater's heat flux —ΔT curve played an important role. These temperatures lie in the film boiling region, but have q A values less than that at point (B). It was necessary to introduce 11.5 KW of primary power to cross the maximum point and pass into the film boiling region. Once film boiling was achieved, primary power had to be rapidly reduced to 6.9 KW for a temperature of 790°C and 4.6 KW for 760°C. (The reduction of primary power was achieved by introducing a 3 phase variac into the power lines external to the induction heater circuit).

An additional phenomenon observed was the effect of the surface chemistry of the specimen. The smooth boiling film developed on the specimens treated at atmospheric pressure was observed to decay in one to two minutes on specimens treated at 760 mm Hg pressure (gage). As the film decayed, the operating temperature of the specimen was reduced several hundred degrees below the desired temperature. It was found that a precarburization of three minutes at atmospheric pressure and 920°C eliminated the film decay. Both specimens were prepared in a similar manner, this indicating that the difference in their performance was due to a surface chemistry change. Other investigators have observed the

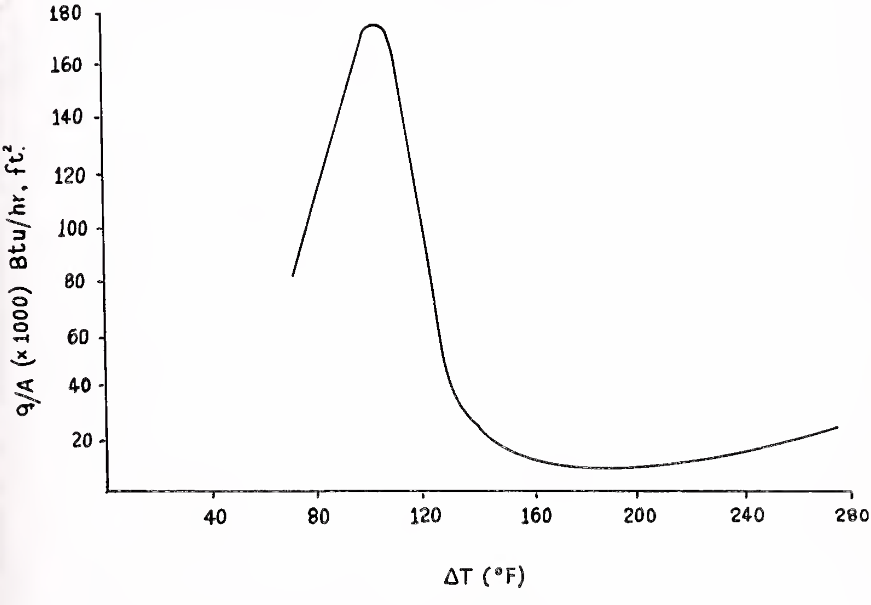

FIGURE 4. Heat flux—ΔT curve for boiling methanol.

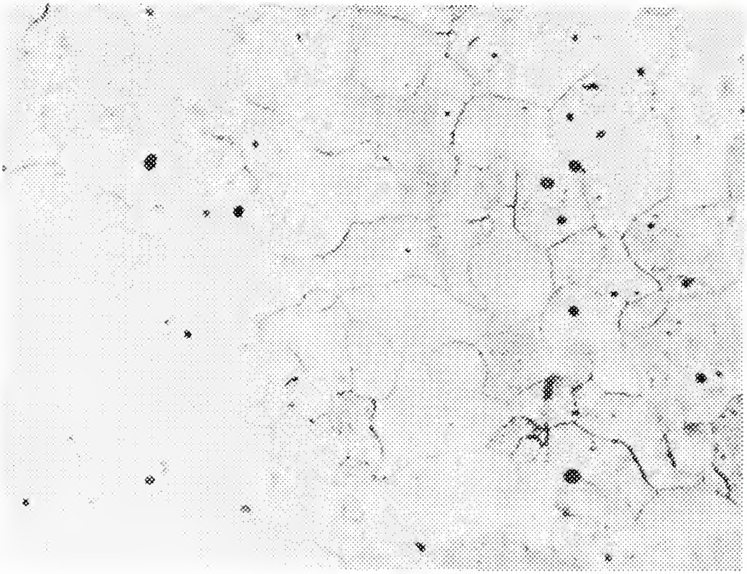

FIGURE 5. Grain size of Armco iron annealed at 760 C for 6 minutes and quenched in 99.7 percent methanol at 60°C, Etchant—4 percent Nital, 250X.

effect of surface condition on the heat transfer characteristics, but dealt only with the mechanical aspects such as roughness (1). It is apparent that, under pressure, the heat transfer characteristics of metals in boiling liquids are very much dependent on the chemical composition of the surface of the metal treated. This observation is consistent with the results of Bonilla (2).

It was noted that samples carburized in benzene were coated, after treatment, with a hard, dense gray scale. Specimens carburized in alcohol had a loose soot formed at the surface. The difference in the nature of this carbon can be traced to the difference in the origin of the carbon. Benzene is a cyclic chemical compound. The carbon extracted from it would be graphitic. This graphite has a hexagonal structure which forms a hard dense scale, in agreement with experimental observation, tending to retard carburization. Alcohol is a chain structure and it appears that for this reason during dissociation the carbon forms amorphous layers of carbonsoot instead of graphite. The soot is permeable and does not retard carburization.

Treatment at 760°C also revealed the development of a carburized case. The carburized case is quite uniform in composition and has advanced on a very smooth front, there being no pearlite connection between the carburized case and the unaffected region of the metal. The case is an advancing austenitic region. If a temperature over-shoot occurs in the first few seconds of treatment, as did occur in this investigation, the surface structure of the metal passes into the gamma region, there being able to readily take carbon into solid solution. After the creation of the austenitic phase at the surface of the specimen, it is possible for it to advance into the specimen. It would assume a constant composition determined by the intersection of a tie line drawn for the temperature being considered, and the A_3 line. The curious thing about it is that the lamellae of pearlite follow consistently the lamellae of ferrite grains as has been pointed out in a previous publication (5). The effect of carburization of iron below the transition temperature (A_3) is rather of academic interest, though, conceivably, it could be applied to the development of some sort of new bimetallics since carburized case has different physical properties than iron itself.

Alcohol concentration variations of 40-99.7 percent did not greatly affect the depth of the case, but did alter the concentration of carbon in the case (see curve, Fig. 7). The lower concentration reduced soot formation and lowered the carbon concentration in the case. Control of the carbon content of the case by this method is readily attained, while for other methods of steel carburization control is rather difficult.

After many hours of use the alcohol remained clear although

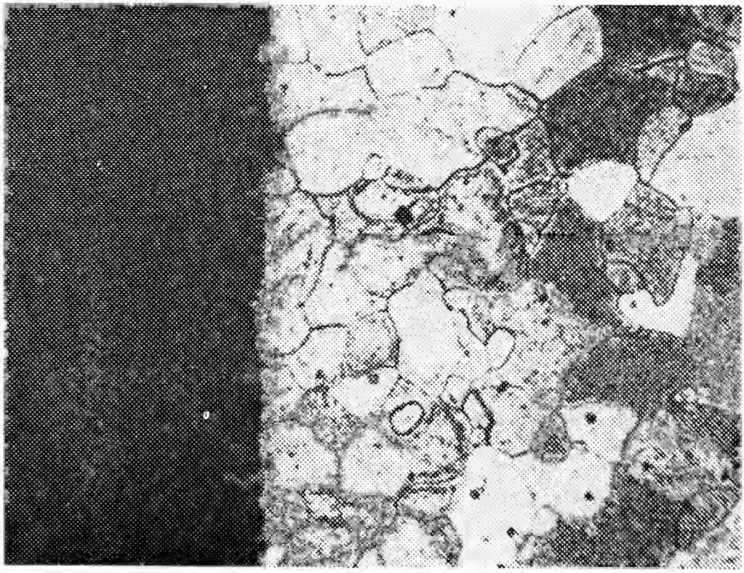

FIGURE 6. Grain size of Armco iron, carburized with induction heat at 760°C for 6 minutes in 99.7 percent methanol. Black case of etched troostite has been formed.

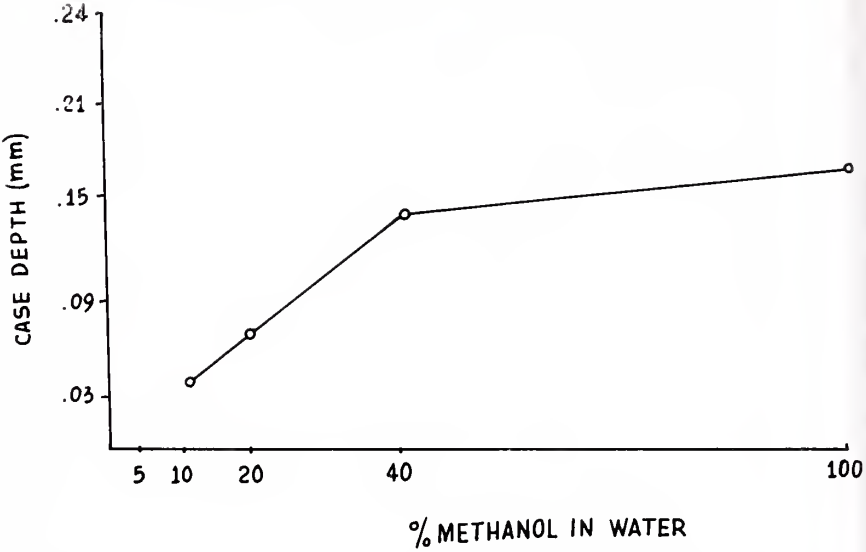

FIGURE 7. Effect of methanol concentration on case depth in Armco iron at 920°C, six minutes, ambient pressure.

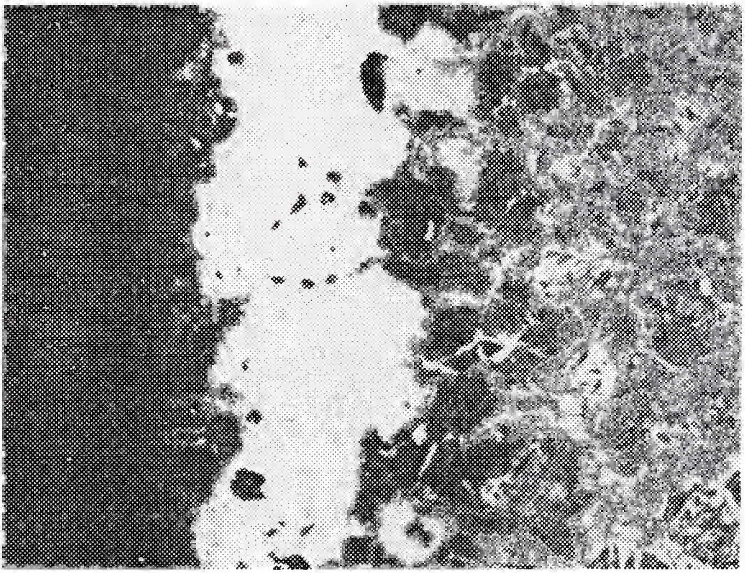

FIGURE 8. 1018 steel precarburized for three minutes at ambient pressure 920°C. Light areas are martensite, dark areas are troostite. Etchant—4 percent nital, 250X.

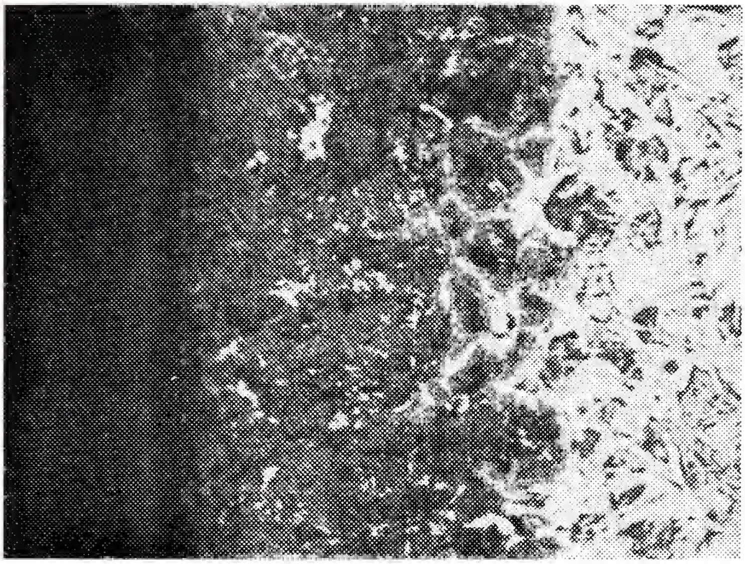

FIGURE 9. 1018 steel, precarburized for 3 minutes at ambient pressure, 920°C in 99.7 percent methanol, and carburized for twelve minutes at ambient pressure at 920°C in 99.7 percent methanol. Note difference in carburized case as compared to Figure 8. Lack of white martensite areas is indicative of lesser carbon concentration leading to formation of troostite only.

the concentration was reduced. This condition could easily be remedied by additions of fresh alcohol.

The specimen was automatically quenched at the end of testing, when the boiling film collapsed. A very fine grained martensite was obtained in the case in specimens carburized under a pressure of 760 mm Hg (gage), as shown in Figure 8. By comparison, no martensite was formed in specimens carburized at atmospheric pressure for twelve minutes (Fig. 9). Fine grained martensite was also obtained due to prolonged carburization at 920°C. Specimens carburized for six minutes (Fig. 10) showed no martensite formation whereas specimens carburized for 24 minutes revealed areas of martensite in the carburized case (Fig. 11). No cracks were observed in the metal after quenching.

CONCLUSIONS

1. This method of carburization provides a simple method of controlling the carbon content of the case.

2. Fine grained martensite was obtained in the case, after an automatic quench, of specimens carburized both under increased pressure and for increased time of carburization in 99.7 percent alcohol at 920°C.

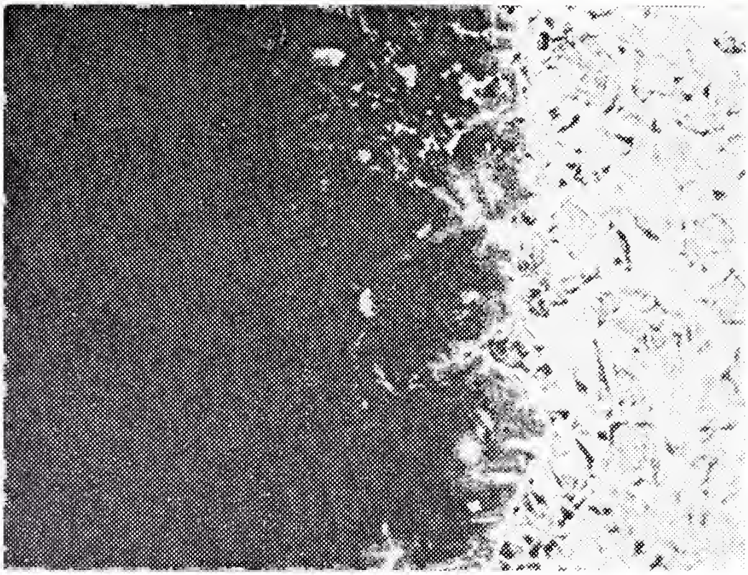

FIGURE 10. 1018 steel, carburized for 6 minutes at 920°C in 99.7 percent methanol, ambient pressure. Case depth 0.13 mm. Etchant—4 percent nital, 250X.

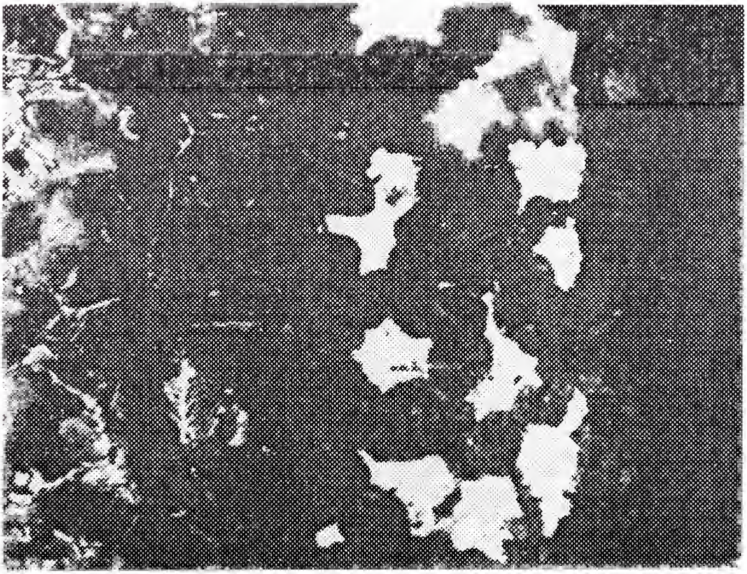

FIGURE 11. 1018 steel, carburized for 24 minutes at 920°C in 99.7 percent methanol, ambient pressure. Light areas are martensite, dark areas troostite. Case depth increased to 0.31 mm. Appearance of martensite indicates higher concentration of carbon than in Figure 10 (effect of longer time of carburization). Etchant—4 percent nital, 250X.

3. The chemical composition of the metal has a pronounced effect on heat transfer from the metal to the boiling liquid, especially for an increased pressure of liquid.

4. Carburization conducted between the A_3 and A_1 line of the iron-carbon equilibrium diagram produces a carburized case of constant composition, consisting predominantly of the austenite phase.

ACKNOWLEDGMENTS

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ABSTRACTS

Biology

Hedyotis rosea Raf. In Alabama

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University of Alabama, University

In the spring of 1965 a very small-flowered species of *Hedyotis* was found growing on the fairways and in the "short rough" of the Tuscaloosa Country Club. Attempts to identify the species using manuals of southeastern plants proved futile. Specimens were sent to Dr. C. E. Wood of the Harvard University Herbarium and he was able to identify the plant as *Hedyotis rosea* Raf. (*Houstonia pygmaea* Mueller and Mueller; Bull. Torrey Bot. Club, 63:33, 1936). Apparently this species is known only from eastern and southeastern Texas. Specimens in the Harvard University Herbarium are from Smith, Dewitt, San Jacinto, and Kauffman counties. To my knowledge this species has not been reported from Louisiana or Mississippi, and this is the first report of its occurrence in Alabama.

The plant is an annual, 1-3 inches tall, and occurs primarily in sandy, open places. It flowers and fruits in late March in Tuscaloosa, Alabama, and is quite inconspicuous except during this brief flowering period. The flowers are pale pink to violet with yellow centers. Apparently this species came in as a contaminant in grass seeds used on the golf course, although no records are presently available to verify this. The seeds of *Hedyotis* are similar to seeds of Bermuda grass.

Science Education

Science Demonstrations: Success Or Failure?

Dutchie S. Riggsby
Troy Junior High School
Troy, Alabama

The purpose of a science demonstration is to teach students the application of a scientific principle. A science demonstration is a failure only if it fails to accomplish this goal. It is a success, then, if it helps the student realize the application of a scientific principle.

One might ask, "How can it fail?" The simplest answer would be "lack of resourcefulness." In the event the anticipated result of a demonstration is negative, there are various means of producing a success of the obvious failure. These methods are: (1) reconstruct the demonstration, (2) introduce the control aspect, and (3) forage out the difficulty via supplying the scientific method.

Whether or not the student learns from a demonstration is the determining factor of success or failure.

The Laboratory Report

Ernest D. Riggsby
Troy State College
Troy, Alabama

The orthodox, fill-in-the-blanks, cookbook-type, laboratory report has come under much criticism in recent literature. Based upon a research project carried out at two colleges, the article offers a few guidelines and suggestions for improving the quality of the written laboratory report. A working hypothesis in the report is that improvement in the quality of laboratory work is likely to accompany any marked improvement in the quality of the written report itself.

Suggested areas are:

1. Improvement of communicability, brevity, utility and clarity
2. Flexibility of written report
3. Replacement of standard, rigid fill-in-the-blanks type reporting form
4. Writing of rationale and critique as a part of laboratory report
5. Use of dimensional analysis, theory of errors, and theory of models
6. Theoretical development
7. Bibliography

A Functional Program For The Preparation Of Secondary School Science Teachers

Joseph C. Thomas
Department of Science
Florence State College, Florence, Alabama

The purpose of this investigation was to locate and study science education programs for the preparation of prospective secondary school science teachers at universities reputedly having outstanding programs in this field. It was believed that these outstanding programs contain information, common practices, and common factors which if combined into one program should form an outstanding program in science education.

To locate universities having outstanding science education programs, letters were sent to select State School Superintendents, a sampled group of noted professors of science education, noted authors in the field, and executive secretaries of science education organizations across the United States. Each was asked to recommend schools having outstanding programs. The recommendations of these persons were tabulated, and the seven schools receiving the largest number of recommendations were visited and studied. The universities studied were: Michigan State University, University of Illinois, New York University, Teachers College—Columbia University, University of Wisconsin, University of Florida, and The Ohio State University.

During visits to each university, a large number of activities were carried out which included interviews with science education professors and with science professors, and the visiting of numerous classes and activities.

The visits were carried out during the 1960-61 school year.

The major recommendations coming from this study were:

1. To prepare students with breadth and depth in science, a comprehensive science major should be offered.

2. To carry out an integrated program in science education, a science teaching center with special facilities should be established with some administrative authority.

3. Regular science courses should be taken but followed by a special course in science designed to acquaint the prospective teacher with new high school programs in the sciences.

4. The undergraduate program for the preparation of science teachers should be divided as follows: (a) 50 percent in science and mathematics, (b) 20 percent in professional education including science education, and (c) 30 percent in "liberal arts" courses.

5. Education courses should include courses in (a) Materials and Methods of Teaching Secondary School Science, (b) a practicum course in science education, and (c) full time student teaching supervised by someone from the science teaching center.

The most essential factor in having an outstanding program for the preparation of secondary school science teachers is cooperation among all professors involved in science teacher programs.

THE JOURNAL

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AFFILIATED WITH THE
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Curran Monroe Farmer

Curran Monroe Farmer was born at Woodlawn, Virginia, November 10, 1880. He received the B.A. degree from Iowa Christian College in 1907, the M.A. degree from the University of North Carolina in 1919, and was awarded the LL.D. degree by Iowa Christian College in 1919. He married Roxie Lee Adams of Surry, Virginia, on June 15, 1910. His son, Curren Adams Farmer, taught for many years at Troy; and his daughter Roxielee is the wife of Dr. John Decker, biologist, of Arizona State University.

He began teaching at the age of 18, spending five years in one-room rural schools and seven years as principal of public high schools. He was dean of men and head of the science department at Atlantic Christian College from 1912 to 1915, and held the same position at Lynchburg (Virginia) College from 1915 to 1920.

Dr. Farmer came to Troy in 1920 and served in a number of capacities as the school developed from a normal school to a teachers college. He was named head of the science department in 1935 and continued in this position until his retirement in 1951. After retirement he remained active in educational and civic affairs until his death in Troy, Alabama, June 14, 1963.

Dr. Farmer was a charter member, an honorary member, and a past president of The Alabama Academy of Science. He took great interest in the Academy from its organization up to the time of his death, at which time he was a member of the Board of Trustees. He was also a charter member of The Association of Southern Biologists, The Southern Association of Science and Industry, and The National Association of Biology Teachers.

Throughout his tenure at Troy, he was a dedicated teacher who took keen interest in the progress of his students, both while they were in college and after their graduation. He fought vigorously for the right of teachers to deal with controversial issues, was a staunch defender of academic freedom, and was held in high esteem by his colleagues, his students, and graduates of the college.

Dr. Farmer was active in civic affairs, being a member of the Board of Deacons of the Troy First Baptist Church, teacher of the men's Baraca class, secretary of the Board of Directors of The Alabama Baptist Children's Home, a Mason, and a member and president of the Troy Rotary Club.

William T. Wilks
Troy State College

Interfacial Activities of Crude Oil Surfactants:

A Mathematical Approach to Mixed Films[1]

PAUL D. CRATIN and ANTHONY M. DEAN[2]
Spring Hill College

INTRODUCTION

Crude oil emulsions stand as a challenge, not only to the theoretician, but to the practical chemist as well. For the theoretician, a study of the causes of, and the cures for, crude oil emulsion stability is complicated by the fact that each crude forms an emulsion different from any other; moreover, a given crude may, for no apparent reason, form emulsions whose properties may, from hour to hour, vary within rather wide limits. (Private communication, Melvin De Groot; deceased).

The study of crude oil emulsions is not without its practical incentives, also, for each year millions of dollars are spent by oil companies in an effort to "break" the water out of these complex systems so that the oil can be refined and marketed. Although demulsification may be accomplished by a variety of methods, the one that is most efficient, most economical, and, to the chemist, most interesting, is that which employs surface-active chemicals, commonly called "surfactants" (10).

The effectiveness with which exceedingly small concentrations of surfactants are able to bring about demulsification is well-known (2); the mechanisms by which these agents are able to accomplish this are not. The highly specific natures and the inherent complexities of emulsions make it impossible to define a single mechanism that is applicable to all emulsion systems. Several authors (1, 2, 9, 10, 11) have postulated that demulsification by chemical agents may take place via several *modi operandi*. For example, breaking of an emulsion may occur by:

(a) precipitation of the emulsifying agent,
(b) displacement of the emulsifying agent from the oil-water interface,
(c) tending to form emulsions of the opposite type, or
(d) several of the above operating simultaneously.

---

[1] This work was supported by a Type-B grant from the Petroleum Research Fund of the American Chemical Society.

[2] Petroleum Research Fund Scholar. Present Address: Department of Chemistry, Harvard University, Cambridge, Mass.

Irrespective of the mechanism(s), it becomes apparent that interfacial activity is a necessary property that the chemical agent must possess to be effective. It is not the *only* criterion, however; indeed, the well-documented studies by Schulman, Cockbain, and others (13, 14), have shown that mixtures of certain interfacially-active materials can even *enhance* the stability of a given emulsion. There is, unfortunately, no way to predict which chemical agent will be effective in destabilizing a given emulsion. Until an intelligent classification of crude oils is established, emulsion technologists must rely solely upon the Edisonian approach.

A study of two classes of crude oil surfactants which are known to be pre-eminent in effecting emulsion stability, the asphaltenes and the resins (2, 6, 7, 8, 9, 12) is reported herein. A third class, the porphyrins, will be the subject of a future study.

MATERIALS AND METHODS

Separation of Asphaltenes and Resins

The separation of the asphaltenes and the resins from several samples of crude oil was performed according to the method outlined by Sachanen (12). When it was desired to preserve anaerobic conditions, the separations were carried out in a dry-nitrogen atmosphere, and the samples were stored in air-tight weighing bottles. Each solvent was de-oxygenated prior to use by sparging with dry nitrogen.

In the experiment where the effect of oxidation of the asphaltenes was studied, no precautions were taken to avoid the presence of oxygen throughout the entire separation procedure.

Preparation of Solutions and Measurement of Interfacial Tension

The non-aqueous phase was prepared by dissolving 5 grams of the material to be studied in 100 ml. of 50-50 (by volume) cyclohexane-benzene. At times it was necessary to heat the mixture to effect more rapid solution of the solid asphaltenes; however, these solutions were always cooled to room temperature before use.

The aqueous phase was prepared by adjusting the solution to the desirable pH with 0.5 N NaOH and HCl. Triply-distilled water was used in all runs and the pH was determined with a pH meter.

Interfacial tension measurements were made with a Cenco-du Nouy tensiometer fitted with a Call ring alignment joint. The general procedure for making the measurements was as outlined in Daniels (5).

Thirty-five ml of the aqueous subtrate were added (by buret) into a 100-ml beaker. The du Nouy ring was then immersed in this phase to insure complete wetting. Next, a 25-ml sample of the asphaltene solution was carefully overlaid (by pipet) on the surface of the aqueous phase. Special care was exercised in discharging the pipet so that turbulence was avoided.

The ring was raised to the oil-water interface and allowed to remain for 5 minutes. The ring was then pulled up through the interface, and the interfacial tension determined from the corrected dial reading. In most cases, the precision was ±0.1 dyne per cm.

RESULTS AND DISCUSSION

The Asphaltenes Interfacial Tension vs. pH

On the basis of some prior work (4, 7, 8), the results of our experimental study of the interfacial tension dependence upon pH (Figure 1) were not entirely unexpected; however, the unusual shape of the curve was unexpected for it had not, to our knowledge, been noted before.

The sensitivity of the asphaltenes to hydronium and hydroxyl ions leads one to believe that these materials are actually amphoteric in nature, similar to the amino acids (3, 15,). It seems quite reasonable that reaction between the asphaltene "Zwitterion" and a hydronium ion results in the formation of a cationic species which is more surface-active than the Zwitterion itself. Likewise, the reaction of the neutral species with a hydroxyl ion leads to the production of an anionic "soap," which is also highly surface-active.

Between the extreme values for the interfacial tension in the low pH region, there appears to be a mixed film consisting of the Zwitterion and the cation from which it is derived. At higher pH's, the Zwitterion co-exists at the interface with the anionic species.

A Mathematical Model for the Asphaltene Mixed Film

For the sake of simplicity, let us assume that the aqueous phase with which the asphaltenes are in contact is highly acidic.* In such a system, essentially all of the amphoteric materials at the oil-water interface will be converted into the cationic species, HZ^+. If the pH of the aqueous phase is now raised by the addition of base, an interfacial reaction ensues that may be represented by the chemical equation:

$$HZ^+ + OH^- = Z^\pm + H_2O.$$

---

* This in no way limits the argument nor invalidates the conclusions. For another approach, the reader is referred to references 3 and 15.

The corresponding equilibrium constant for this reaction is given by:

$$K_b = \frac{[HZ+]\ [OH-]}{[Z\pm]}. \tag{1}$$

Using the same argument, let us assume that the pH of the aqueous phase is now very high. Physically, this means that practically all of the interfacial materials are present as anionics, Z^-. The addition of strong acid to the water phase will result in a lowering of the pH and will bring about the interfacial reaction:

$$Z^- + H^+ = Z^\pm,$$

whose equilibrium constant may be written:

$$K_a = \frac{[H+]\ [Z-]}{[Z\pm]}. \tag{2}$$

From stoichiometric considerations, it is evident that the *total* concentration of species, $(Z)_t$, is

$$[Z]_t = [Z\pm] + [HZ+] + [Z-]. \tag{3}$$

The ill-defined nature of the asphaltenes and their derivatives and our inability to measure interfacial concentrations require the conversion of concentration into the fractions, $f_\pm$, f_+, and f_-. This is accomplished by dividing the concentration of a given species by the total concentration present, e.g.,

$$f_\pm = \frac{[Z\pm]}{[Z]_t}.$$

To illustrate the mechanics of getting the various fractions as functions of the hydrogen ion concentration, let us consider a single case, that of $f_\pm$.

$$[Z]_t = [Z\pm] + [HZ+] + [Z-]. \tag{3}$$

Now, by rearranging (1) and (2),

$$[Z-] = K_a \frac{[Z\pm]}{[H+]} \tag{2a}$$

and

$$[HZ+] = K_b \frac{[Z\pm]}{[OH-]}. \tag{1a}$$

Recalling that

$$[H^+]\ [OH^-] = K_w,$$

and substituting into 1a, we find that

$$[HZ+] = \frac{[H+]\ [Z\pm]\ K_b}{K_w}. \tag{1b}$$

If (1b) and (2a) are inserted into (3),

$$[Z]_t = [Z^{\pm}] + K_a \frac{[Z^{\pm}]}{[H^+]} + \frac{K_b\,[H^+]\,[Z^{\pm}]}{K_w}, \tag{4}$$

which may be simplified to

$$[Z]_t = [Z^{\pm}]\left\{1 + \frac{K_a}{[H^+]} + \frac{K_b\,[H^+]}{K_w}\right\}. \tag{5}$$

The fraction of the Zwitterion is then given by

$$f_{\pm} = \frac{[Z^{\pm}]}{[Z]_t} = \frac{1}{1 + \dfrac{K_a}{[H^+]} + \dfrac{K_b\,[H^+]}{K_w}}. \tag{6}$$

Employing identical modes of reasoning, one can derive similar expressions for f_+ and f_-:

$$f_+ = \frac{[HZ^+]}{[Z]_t} = \frac{1}{1 + \dfrac{K_w}{K_b\,[H^+]} + \dfrac{K_a\,K_w}{K_b\,[H^+]^2}}, \tag{7}$$

and

$$f_- = \frac{[Z^-]}{[Z]_t} = \frac{1}{1 + \dfrac{[H^+]}{K_a} + \dfrac{[H^+]^2\,K_b}{K_a\,K_w}}. \tag{8}$$

In order to calculate the various fractions as a function of the pH, it is necessary to know K_a and K_b. These values were obtained in the following manner:

Aware that the amphoteric asphaltenes are quite similar to the amino acids, we constructed a plot of $f_{\pm}$ vs. pH for glycine (2). The curve obtained was identical in shape to that given in Figure 1. Upon further analysis, it was found that, in the case of glycine, the inflection point in the left hand leg occurred when $[Z^{\pm}] = [HZ^+]$, that is, at half-neutralization, so that $\mathrm{pH} = 14 - \mathrm{p}K_b$. On the right hand side, the inflection point corresponded to the condition $[Z^{\pm}] = [Z^-]$, (again, at half-neutralization), so that $\mathrm{pH} = \mathrm{p}K_a$. The maximum in the glycine curve occurred at the isoelectric point, i.e., where $[H^+] = \sqrt{\dfrac{K_a\,K_w}{K_b}}$.

To complete the argument, we reasoned that the interfacial tensions of the asphaltenes are directly related to the fraction of Zwitterion present. Thus, $f_{\mp}$ will be a maximum at the charge-

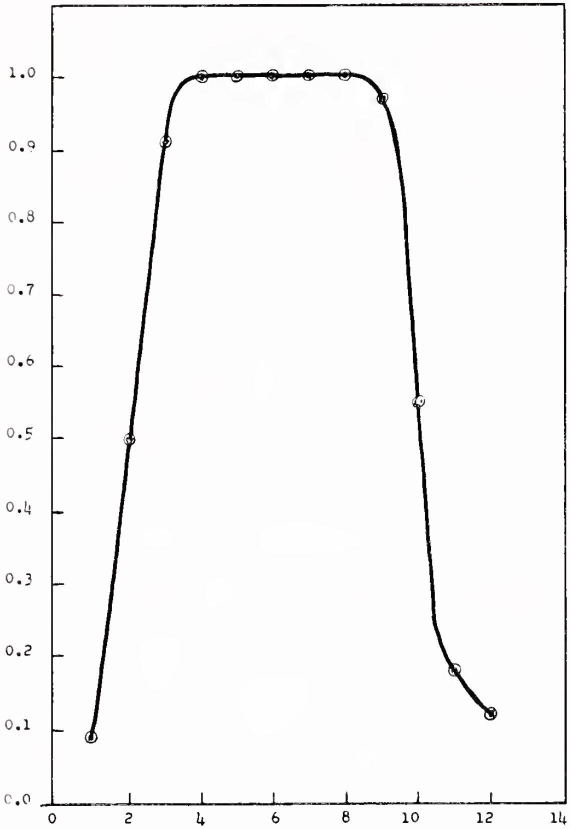

FIGURE 1. Experimental values of $\frac{\delta i}{\delta o}$ vs. pH—Asphaltenes

neutralization (i.e., isoelectric) point; since the interfacial *activity* will be a minimum here, the interfacial *tension* will be at its maximum value. The decrease in $f_{\pm}$ is accompanied by an increase in f_{+} or f_{-}, depending upon pH, and, since these materials are more interfacially active than $Z^{\pm}$, the interfacial tension will accordingly decrease.

It is now possible to use Figure 1 to determine the pH values at which equimolar mixtures of the Zwitterion and the charged species co-exist at the interface. From the pH values taken at the two points of inflection K_a and K_b were calculated with the equations:

$$pK_b = 14 - pH \text{ (left-hand side)}$$

and

$$pK_a = pH \text{ (right-hand side)}.$$

The values of K_a and K_b were found to be:

$$K_a = 10^{-10} \text{ and } K_b = 10^{-12}.$$

A compilation of the fraction of each species as a function of the pH is given in Table 1.

As a consequence of this analysis, there now exists a method to determine whether these species which co-exist at the interface do so independently or do so antagonistically. If they co-exist independently, then the activities of the species will remain constant throughout the pH range over which they are present. Should they exhibit an antagonistic effect, this will be reflected in the inconstancy of their activities.

Interfacial Activity Defined

A new definition of interfacial activity, based upon the relative lowering of the interfacial tension, is now introduced:

$$a = \frac{\delta_o - \delta_i}{\delta_o} \tag{9}$$

In equation (9), a is the activity, δ_i is the measured interfacial tension, and δ_o is the "standard state" interfacial tension. δ_o is, physically, the value of δ at the "isoelectric point" of the system.

TABLE 1. The Asphaltenes: $f_\pm$, f_+, and f_- as a function of pH

pH	$f_\pm$	f_+	f_-
0	0.01	0.99	10^{-10}
1	0.09	0.91	10^{-9}
2	0.5	0.5	10^{-8}
3	0.91	0.09	10^{-7}
4	0.99	0.01	10^{-6}
5	0.99+	10^{-3}	10^{-5}
6	0.99+	10^{-4}	10^{-4}
7	0.99+	10^{-5}	10^{-3}
8	0.99	10^{-6}	0.01
9	0.91	10^{-7}	0.09
10	0.5	10^{-8}	0.5
11	0.09	10^{-10}	0.91
12	0.01	10^{-12}	0.99
13	10^{-3}	10^{-14}	0.99+
14	10^{-4}	10^{-16}	0.99+

$K_a = 10^{-10}$ $K_b = 10^{-12}$

This unique definition of activity sets definite limits on the numerical value of a when: (1) a substance exhibits no interfacial activity, $\delta_i = \delta_o$, and a = 0, (2) a substance shows an extremely high degree of interfacial activity that results in $\delta_i \rightarrow 0$, then a → 1.

If the species at the interface co-exist *independently*, then the total activity will be equal to the contributions from each species, that is,

$$a_t = \frac{\delta_o - \delta_i}{\delta_o} = \sum_i a_i f_i \tag{10}$$

or,

$$\frac{\delta_i}{\delta_o} = 1 - (a_\pm f_\pm + a_+ f_+ + a_- f_-). \tag{11}$$

At this time, the activity of the Zwitterion, $a_\pm$, is arbitrarily defined to be zero. Strictly speaking, the asphaltene Zwitterions *do* exhibit a lowering of the interfacial tension, so the absolute value of $a_\pm$ is not zero. The manner in which δ_o is defined obviates the necessity of knowing the absolute activity of the Zwitterion, and thereby justifies our setting $a_\pm = 0$. Equation (11) now becomes:

$$\frac{\delta_i}{\delta_o} = 1 - (a_+ f_+ + a_- f_-). \tag{12}$$

The working equation from which a δ_i/δ_o vs. pH curve may be constructed is obtained by substituting (7) and (8) into (12). The result is:

$$\frac{\delta_i}{\delta_o} = 1 - \left\{ a_+ \left[\frac{1}{1 + \frac{K_w}{K_b\,[H^+]} + \frac{K_a\,K_w}{K_b\,[H^+]^2}} \right] + a_- \left[\frac{1}{1 + \frac{[H^+]}{K_a} + \frac{[H^+]^2\,K_b}{K_a\,K_w}} \right] \right\}. \tag{13}$$

As written, equation (13) contains two unknowns, a_+ and a_-. It is possible to determine these activities provided two values of δ_i/δ_o are known at two different hydrogen ion concentrations.

(1) At pH = 10, $f_+ = 10^{-8}$, $f_- = 0.5$, and $\delta_i/\delta_o = 0.55$.

(2) At pH = 2, $f_+ = 0.5$, $f_- = 10^{-8}$, and $\delta_i/\delta_o = 0.50$.

Solving the two simultaneous equations for a_+ and a_- we obtain:

$$a_+ = 1.00 \tag{14}$$

$$a_- = 0.90 \tag{15}$$

and

In its final form, equation (13) becomes:

$$\frac{\delta_i}{\delta_o} = 1 - \left\{ 1.00 \left[\frac{1}{1 + \dfrac{K_w}{K_b\,[H^+]} + \dfrac{K_a\,K_w}{K_b\,[H^+]^2}} \right] + 0.90 \left[\frac{1}{1 + \dfrac{[H^+]}{K_a} + \dfrac{[H^+]^2\,K_b}{K_a\,K_w}} \right] \right\}. \qquad (16)$$

From equation (16), Table 2 was compiled. A graphical comparison of the theoretical (equation 16) with the experimental is depicted in Figure 2.

Interpretation of Results

Within the limits of experimental error, the correlation between experiment and theory is almost perfect. The fact that the entire curve can be reproduced from only two data points seems remarkable.

In view of the assumptions made in the mathematical analysis, we interpret this close correlation to mean that both asphaltenes and their ionic derivatives co-exist *independently* at the interface over the entire pH range. There is no evidence of complex formation nor of any other antagonistic effects.

TABLE 2. The Asphaltenes: Calculated and experimental values of $\delta i/\delta o$ as a function of pH

pH	$\delta i/\delta o$ (calc.)	$\delta i/\delta o$ (exp.)
0	0.01	—
1	0.09	0.09
2	0.50	0.50
3	0.91	0.91
4	0.99	1.00
5	0.99+	1
6	0.99+	1
7	0.99+	1
8	0.99	1
9	0.92	0.97
10	0.55	0.55
11	0.18	0.18
12	0.1	0.12
13	0.1	----
14	0.1	
$a_{\pm} = 0.00$	$a_{+} = 1.00$	$a_{-} = 0.90$
$K_a = 10^{-10}$	$K_b = 10^{-12}$	$\delta o = 21.0$ dynes cm^{-1}

The rather broad maximum in Figure 1 occurs in the pH interval where *water-in-oil* emulsion stability is greatest due to the

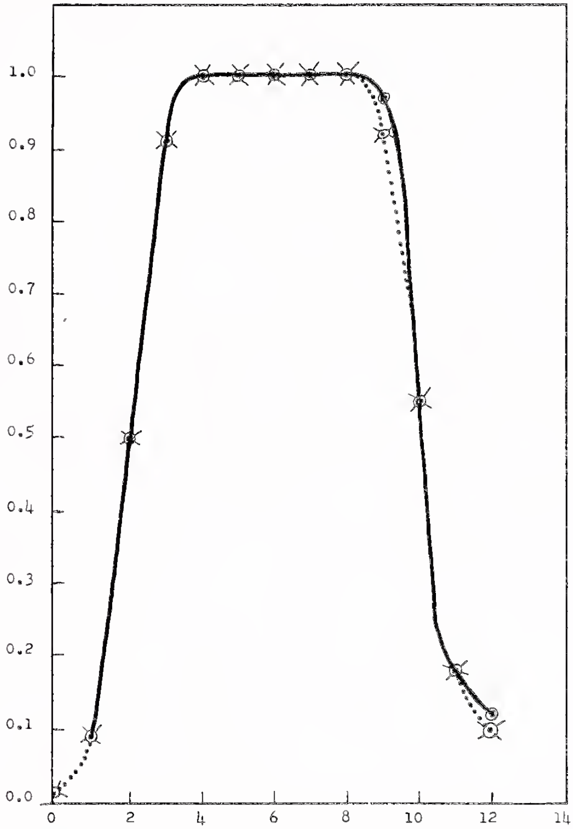

FIGURE 2. Experimental (solid lines) and theoretical (broken lines) values of δi/δo vs. pH—Asphaltenes

formation of rigid interfacial films. It likewise corresponds to the region where the predominant surface-active species is the Zwitterion. As the pH is increased – and decreased – the interfacial tension undergoes a rapid drop approaching zero in the limit, a value which is necessary for the stabilization of *oil-in-water* emulsions. These emulsions are stabilized not by *rigid* films, but by "mobile," or surfactant-type moieties (13, 14).

In the transition from rigid to surfactant films, the system passes through a phase-inversion point, that is, a region where a water-in-oil emulsion inverts to become an oil-in-water type.* Hence, it is at the phase-inversion point that emulsion stability will be at a minimum. Before the phase-inversion point is reached, the great majority of surfactants present at the interface are then tending to stabilize *water-in-oil* emulsions by the formation of rigid films. Beyond the phase-inversion point, the greater number of surfactant molecules present are those which tend to stabilize *oil-in-water* emulsions through electrical effects and a low interfacial tension.

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* The reverse is also true.

We therefore conclude that regions of minimum stability occur when approximately equal numbers of two types of surfactants are present at the interface. These regions correspond precisely to the points of inflection on our δ_i/δ_o vs. pH curve. The region of minimum stability below the isoelectric point will be when $[HZ^+] = [Z^\pm]$; above the isoelectric point, minimum stability occurs when $[Z^-] = [Z^\pm]$.

The Resins

Interfacial Tension vs. pH

In the chemical literature, resins are classified as "neutral" species (12); as such, pH should have no effect on their interfacial tensions. However, our experimental findings, as illustrated in Figure 3, show that there exists a very strong dependence of δ upon pH.

The general shape of the curve, with its two pronounced "breaks," greatly resembles the pH-volume curve obtained when a mixture of strong and weak acids is titrated with a strong base.

Since, at very low pH values the interfacial tension is a maximum, one may infer the absence of basic groups in the resin molecule. The two rather pronounced "breaks" at higher pH's suggest that (at least) two different acidic groups are present in the resin molecule.

Qualitatively, it appears that at low pH values only one species exists at the oil-water interface. As the pH is increased, partial neutralization of the resins results in a mixed film at the interface. Increasing the pH still further brings about an additional reaction between the partially-neutralized resin molecules and the hydroxyl ion. At intermediate pH's, it is probable that a second mixed interfacial film is formed, and at very high pH values only a single, highly surface-active species is present.

A Mathematical Model for the Resin Mixed Film

Let us assume that the "formula" of the resin molecule can be represented by H_2A.

As with any "dibasic" acid, the successive ionization equilibria may be represented by:

$$H_2A = H^+ + HA^- \qquad (17)$$

and

$$HA^- = H^+ + A^= \qquad (18)$$

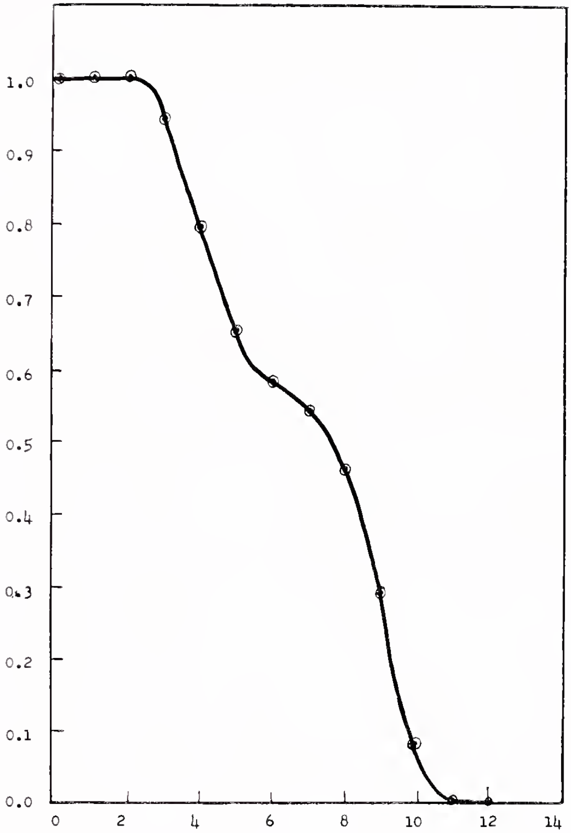

FIGURE 3. Experimental values of $\frac{\delta i}{\delta o}$ vs. pH—Resins

The corresponding equilibrium consists for (17) and (18) are:

$$K_1 = \frac{[H^+]\,[HA^-]}{[H_2A]} \tag{19}$$

and

$$K_2 = \frac{[H^+]\,[A^=]}{[HA^-]}. \tag{20}$$

From stoichiometric considerations, it is obvious that the total concentration of resin, $[R]_t$, is

$$[R]_t = [H_2A] + [HA^-] + [A^=]\,. \tag{21}$$

For the same reasons given for the asphaltenes it is necessary to convert concentrations into fractions, i.e.,

$$f_o = \frac{[H_2A]}{[R]_t}\,, \qquad f_- = \frac{[HA^-]}{[R]_t}\,,$$

and

$$f_{=} = \frac{[A^{=}]}{[R]_t}.$$

To illustrate again the mechanics of getting the fractions as functions of the hydrogen ion concentration, let us consider a single case, that of f_o.

$$[R]_t = [H_2A] + [HA^-] + [A^=]\,. \tag{21}$$

By rearranging (19) and (20),

$$[HA^-] = K_1 \frac{[H_2A]}{[H^+]}, \tag{19a}$$

and

$$[A^=] = K_2 \frac{[HA^-]}{[H^+]}. \tag{20a}$$

Furthermore, by substituting (19a) into (20a),

$$[A^=] = K_1\ K_2 \frac{[H_2A]}{[H^+]^2}. \tag{20b}$$

When (19a) and (20b) are inserted into (21):

$$[R]_t = [H_2A] + K_1 \frac{[H_2A]}{[H^+]} + K_1\ K_2 \frac{[H_2A]}{[H^+]^2}, \tag{22}$$

which is easily simplified to

$$[R]_t = [H_2A] \left\{ 1 + \frac{K_1}{[H^+]} + \frac{K_1\ K_2}{[H^+]^2} \right\}. \tag{23}$$

The fraction of undissociated resin, f_o, is

$$f_o = \frac{1}{1 + \dfrac{K_1}{[H^+]} + \dfrac{K_1\ K_2}{[H^+]^2}}. \tag{24}$$

In an identical manner, f_- and $f_=$ can be determined:

$$f_- = \frac{1}{1 + \dfrac{[H^+]}{K_1} + \dfrac{K_2}{[H^+]}}, \tag{25}$$

and

$$f_= = \frac{1}{1 + \dfrac{[H^+]}{K_2} + \dfrac{[H^+]^2}{K_1\ K_2}}. \tag{26}$$

In order to calculate the various fractions as functions of the hydrogen ion concentration, one needs to know K_1 and K_2. In a manner not unlike that used to calculate K_a and K_b for the asphaltenes, this can be done from an inspection of the δ_i/δ_o vs. pH curve given in Figure 3. At the first (left-hand side) inflection point, $[H_2A] = [HA^-]$, so $pH = pK_1$. At the second inflection point, $[HA^-] = [A^=]$, and $pH = pK_2$. The values of K_1 and K_2 determined in this manner were found to be:

$$K_1 = 10^{-4} \text{ and } K_2 = 10^{-9}.$$

The fractions of the three species as functions of the pH are given in Table 3.

This gives a second method for determining whether these species co-exist at the interface independently or if they exhibit antagonistic effects. The constancy — or inconstancy — of the activities, as before, provides the answer.

Interfacial Activity Introduced

By using the same definition of the interfacial activity, and assuming the independent interfacial co-existence of the various species,

$$\frac{\delta_i}{\delta_o} = 1 - (a_o f_o + a_- f_- + a_= f_=) \,. \tag{27}$$

Setting $a_o = 0$, equation (27) becomes

$$\frac{\delta_i}{\delta_o} = 1 - (a_- f_- + a_= f_=) \,. \tag{28}$$

TABLE 3. The Resins: f_o, f_-, and $f_=$ as a function of pH

pH	f_o	f_-	$f_=$
0	0.99+	10^{-4}	10^{-13}
1	0.99+	10^{-3}	10^{-11}
2	0.99	0.01	10^{-9}
3	0.91	0.09	10^{-7}
4	0.5	0.5	10^{-5}
5	0.09	0.91	10^{-4}
6	0.01	0.99	10^{-3}
7	10^{-3}	0.99	0.01
8	10^{-4}	0.91	0.09
9	10^{-5}	0.5	0.5
10	10^{-7}	0.09	0.91
11	10^{-9}	0.01	0.99
12	10^{-11}	10^{-3}	0.99+
13	10^{-13}	10^{-4}	0.99+
14	10^{-15}	10^{-5}	0.99+

$K_1 = 10^{-4}$ $\qquad$ $K_2 = 10^{-9}$

The working equation needed to construct the δ_i/δ_o vs. pH curve is obtained by substituting into (28) equations (25) and (26).

$$\frac{\delta_i}{\delta_o} = 1 - \left\{ a_- \left[\frac{1}{1 + \frac{[H^+]}{K_1} + \frac{K_2}{[H^+]}} \right] + a_= \left[\frac{1}{1 + \frac{[H^+]}{K_2} + \frac{[H^+]^2}{K_1\,K_2}} \right] \right\}. \qquad (29)$$

To calculate the values for a_- and $a_=$, δ_i/δ_o is needed at two different hydrogen ion concentrations.

(1) At pH $= 4$ $f_o = 0.5$, $f_- = 0.5$, $f_= = 10^{-5}$, and $\delta_i/\delta_o = 0.79$.

(2) At pH $= 9$ $f_o = 10^{-5}$, $f_- = 0.5$, $f_= = 0.5$, and $\delta_i/\delta_o = 0.29$.

Solving the two simultaneous equations for a_- and $a_=$ we find:

$$a_- = 0.42$$

and

$$a_= = 1.00$$

In its final form, equation (29) reads:

$$\frac{\delta_i}{\delta_o} = 1 - \left\{ 0.42 \left[\frac{1}{1 + \frac{[H^+]}{K_1} + \frac{K_2}{[H^+]}} \right] + 1.00 \left[\frac{1}{1 + \frac{[H^+]}{K_2} + \frac{[H^+]^2}{K_1\,K_2}} \right] \right\}. \qquad (30)$$

From equation (30) Table 4 was compiled. A graphical comparison of the theoretical (equation (30)) with the experimental is shown in Figure 4.

Interpretation of Results

Again, the correlation between experiment and theory is excellent. As before, the entire curve can be reproduced from only two data points. Over the entire pH range, it appears that these species co-exist independently at the oil-water interface, and little, if any, interference between species is noted.

The success of this theory is not limited to reproduction of an experimental curve alone. It also gives the numerical values for the activities of the various ionic species present. For example, if one

TABLE 4. The Resins: Calculated and experimental value of $\delta i/\delta o$ as a function of pH

pH	$\delta i/\delta o$ (calc.)	$\delta i/\delta o$ (exp.)
0	1	1
1	1	1
2	1	1
3	0.96	0.94
4	0.79	0.79
5	0.62	0.65
6	0.58	0.58
7	0.57	0.54
8	0.53	0.46
9	0.29	0.29
10	0.06	0.08
11	0.01	0
12	0	0
13	0	0
14	0	0
$a_o = 0.00$	$a_- = 0.42$	$a_= = 1.00$
$K_1 = 10^{-4}$	$K_2 = 10^{-9}$	$\delta_o = 24.1$ dynes cm^{-1}

considers the values of a_- (= 0.42) and $a_=$ (= 1.00) we see that the activity of the doubly-charged group is approximately two and one-half times that of the singly-charged species. This states *quantitatively* what we have known qualitatively for many years — as the charge on an ion increases, the greater is the tendency for the ion to leave a phase of lower dielectric constant for a phase whose dielectric constant is much higher.

ADDENDA

Additional δ_i/δ_o vs. pH runs were made with asphaltenes which had been exposed to the air during separation and purification.

Results in brief were:

(1) The numerical values of K_a and K_b remained unchanged, (within experimental error).

(2) The activity of the anionic species, a_-, rose to 1.00.

(3) The activity of the cationic species, a_+, dropped to 0.14.

Again, this is in agreement with qualitative predictions. The rise in a_- can be attributed to the partial oxidation of the asphaltenes to yield acid (— COOH?) groups. An increase in the *number* of these results in an increase in the *activity*. The decrease in the activity of the cationics may be due to the oxidation of some basic groups (— NH_2?) to the non-basic species (— NO_2?). What does seem to be important again is the magnitude of the change — 86% of the basic groups were effectively destroyed by air oxidation.

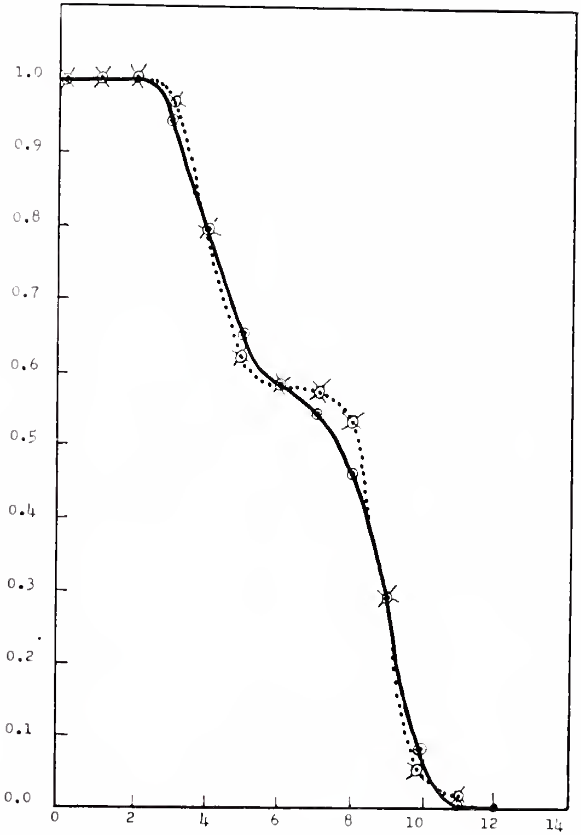

FIGURE 4. Experimental (solid lines) and theoretical (broken lines) values of $\delta i/\delta o$ vs. pH—Resins

ACKNOWLEDGEMENT

Acknowledgement is made to the donors of The Petroleum Research Fund, administered by the American Chemical Society, for support of this research. Thanks are also due Chevron Asphalt Company and Esso Production Company who supplied the crude oil samples for this study. A special acknowledgement is due Dr. J. E. Strassner for his many helpful discussions with one of us (PDC).

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Citizenship Through Leadership—A Look Ahead[1]

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Forecasting the future of the Alabama Academy should be left to the prophets and crystal ball gazers. Since I am now cast in the roll of predicting this future, I'll do my best.

I predict that by 1975:

1. The membership of the Academy will grow to 1200 members.
2. The JOURNAL will double in number of pages per volume.
3. The NEWSLETTER will grow in number of pages by 50 percent.
4. The budget of the Academy will have to nearly double to pay for expanded services to the members.
5. The number of sections will increase from 10 to 15 to serve separate disciplines now represented in existing sections and accommodate new ones.
6. The number of science clubs represented in the Junior Academy will increase in number by one third.
7. Science Fairs will grow in size, unless restricted.
8. Exhibits before the Academy at its annual meeting will double in number, unless restricted.
9. Attendance at the future meetings of the Academy will increase to 700 persons representing both the Junior and Senior academies.
10. The number of awards given in recognition of scientific accomplishment should double and perhaps become identified with the various scientific endeavors such as biology, physics, etc.

These are the 10 predictions for the decade ending in 1975.

I would like to get into a bit of philosophy – philosophy that must be understood and put into practice if the predictions just made are to come true.

You and I are people. The Academy is made up of people. People at work are required if goals are to be reached. Not all people will possess the interest and desire to serve the Academy but somewhere along the road of years, people must assume positions of leadership. It is about this quality of the individual that I would now like to address my remarks.

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[1] Presented at annual banquet, Alabama Academy of Science and Junior Academy, Birmingham-Southern College, April 1, 1966.

"Citizenship through leadership" may sound like a very sophisticated title for this address. Let us overlook the sophisticated sound of the title and examine its meaning.

Our society today requires that citizenship, in all of its many facets, be practiced. Unless there is evidence that you and I are exercising the rights of citizenship, the future of the society in which we live is in jeopardy. Furthermore, if citizenship is not practiced, leadership is lacking.

First let me define the key words used in the title of this address.

The legal definition of the word citizenship includes the duties, rights, and privileges granted a person who by birth or choice is a member of a state or nation. Let me suggest that citizenship has a social connotation also. This meaning extends to the practice of the duties, rights and privileges that are ours as we seek to develop as citizens in our respective schools, professions, and trades. Thus, citizenship has little meaning in a social sense unless we become leaders and use our own talents for the good of society.

Leadership is the process through which abilities of the individual to influence thinking and actions of others are demonstrated. The world today is experiencing a shortage of true leaders in every field at the local level. Because of this shortage, the actions and thinking of the great masses of society that make up our population lack guidance. Through lack of proper guidance realization of the potentials of an informed citizenry are reduced.

The opportunities that exist for youth in the Alabama Junior Academy of Science and the Science Fairs program, and for adults in the Alabama Academy of Science for development of leadership ability are numerous, exciting, and challenging. The Academy and its sponsored programs provide the media through which leadership experience may be gained. This experience, when put into practice, is evidence that citizenship is alive and not just a talked-about phrase.

I previously stated that leadership is a process through which one exerts his influence on the thinking and actions of others. Let us examine the concepts and components of leadership. To become a leader one must gain experience. This experience must then be applied to a task. Successful completion of the task is demonstrative of leadership ability.

The Alabama Academy of Science came into being in 1924. Individuals interested in science, believing that their leadership could bring together others from diverse disciplines, laid the premise for an action program that now includes more than 700 scientists. Leaders in the Academy saw ways of encouraging youth in scientific endeavors. Thus, the Alabama Junior Academy of Science was conceived in 1933. Unique opportunities for the development of leadership through the Science Fairs were recognized by Academy leaders. The Junior Academy and Science Fairs have each developed to what they are today through the leadership given.

Probably the greatest contribution the Academy has made through its leadership is evidenced by the presence here of so many future scientists. Each of you by your efforts and your presence here has already experienced some of the growth process I refer to as leadership. You have been a member of an organization. Some of you have served on committees, while some have gained leadership experience through an elected office. Others, through competition, have learned something of leadership by exhibition or preparation of a formal paper. Each of you have the unique opportunity of looking forward to being a leader of the future in your chosen field. Those of us who are adults will continue to dedicate our lives to strengthening citizenship through our efforts as leaders. Thus, experience is an important ingredient of leadership.

Let us look now to how our experience may contribute to our future leadership and hence becoming better practioners of citizenship.

More and better leaders are needed in social endeavors, politics, science, the military, education and in many other fields. In my opinion, the leaders of tomorrow will emerge through one of three processes. Some will become leaders because of their technical accomplishments. Others will be selected by more experienced leaders because of their personal qualities including character, personality, and native ability. Some will also become leaders by the force of their character. Although your goal may not be that of becoming a leader because of your personal qualifications, you will be continually judged by your superiors and many of you will be selected for positions of leadership. Make the best of each of these opportunities. Others will follow you because of your leadership abilities. You will be making a contribution to the building of citizenship when you accept these opportunities and discharge your attendant responsibilities to your fellow man.

Many of you will contribute your leadership ability to projects, programs, and to extra-curricular activities outside your chosen field. For example, the high school science teacher may become a leader in the arts of his community through an avocation or hobby. The business executive may make a significant contribution to his community through a civic club. The scientist may lend his talents to youth programs, such as Boy Scouts, Girl Scouts, and Science Fairs.

The businessman may lead his community in supporting projects of the local school, church, or industrial complex.

There are at least two ways in which leaders are repaid for their efforts. One is the honor of being chosen to lead and the other is the reward of accomplishment.

I would like to make a few projections that may stimulate you to higher goals through leadership.

The leader of tomorrow will be recognized because he did a little more than was expected. He must also do some of the routine things differently through innovation.

The leader of tomorrow will have to be more knowledgeable. He will also have to possess the ability to communicate his knowledge and wisdom clearly and forcefully.

The leader of tomorrow will have to refine his thinking and continue to be a learner or the world will pass him by.

The leader of tomorrow will be a leader because of the contributions he makes to society outside his chosen vocation or profession.

The leader must lead in the right direction. Great leaders of the past, present, and future have had and will continue to have one thing in common . . . the ability to inspire confidence in his own integrity and responsibility.

Your role in the future will be determined by you. Your leadership potential will be based on leadership experience as judged by others. Your contribution as a citizen to the citizenship building of your community, state, and nation may be challenged by some. Real leadership is measured by progress. Leadership without citizenship is meaningless. Leadership by example that gains followers rather than leadership for power or recognition will be lasting leadership.

ABSTRACTS

Biology

Preliminary Herpetological Investigations In Amazonian Ecuador

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Herpetological and ichthyological investigations were conducted in the eastern rainforests of Ecuador (the Oriente) in 1963. Prior to the incursions into the Oriente in 1963, a single North American zoological expedition had entered the Oriente (1868).

To date, over 8,000 reptiles and amphibians and over 10,000 fishes have been collected in eastern Ecuador. Significant series have been secured from localities on Río Napo, Río Payamino, Río Jivino, Río Aguarico, Río Tiputini, and Río Yasuní. Thus, collections have been obtained from northern and central Oriente.

In the summer of 1966, investigations will be directed toward the southern Oriente from Rio Santiago eastward to and beyond Rio Pastaza.

Influence Of Aeration On Aflatoxin Production By *Aspergillus flavus* In Submerged Culture

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Aspergillus flavus (ATCC 15517) produced up to 127.5 mg/l total aflatoxins when grown in submerged culture in 14-liter fermentors and subjected to aeration and agitation. The medium consisted of 2% yeast extract and 10 or 15% sucrose (YES medium). Incubation was for 5 days at 30 C with a stirring rate of 100 rpm in a New Brunswick Three-Unit Fermentor Drive Assembly, Model FS-314. Aeration was at the rates of 3,000, 6,000, 9,000 and 12,000 cc/min.

Aflatoxin production increased with time throughout the 5-day experiment and reached a maximum of 127.5 mg/l at 12,000 cc/min aeration rate and 113.1 mg/l at 9,000 cc/min. Only 10.5 and 17.5 mg/l aflatoxins were produced at 6,000 and 3,000 cc/min, respectively. Mycelial dry weights on the 5th day ranged from 52.7 to

57.7 g/l at aeration rates from 6,000 to 12,000 cc/min, but was only 33.6 g/l at 3,000 cc/min.

Influence Of Carbon Dioxide, Nitrogen, And Oxygen On Growth And Sporulation By *Aspergillus flavus* On Peanuts

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Sound, mature peanut kernels were surface disinfected with 1% sodium hypochlorite, inoculated with *Aspergillus flavus,* and incubated for 2 weeks at high moisture levels and 30 C under various concentrations of atmospheric gases. No reduction in growth and sporulation of *A. flavus* occurred when the carbon dioxide concentration was increased from the amount present in air to 20%. A reduction in fungus growth and sporulation occurred with each 20% increase in carbon dioxide from 20 to 80%. No growth and sporulation occurred in 100% carbon dioxide. No apparent decreases in growth or sporulation occurred when oxygen was reduced from 20 to 5%, regardless of whether 0, 20, or 80% carbon dioxide was present. However, striking reductions in growth and sporulation occurred when oxygen was reduced from 5 to 1% with 0, 20, or 80% carbon dioxide.

The percentage of free fatty acids for peanuts inoculated with *A. flavus* and incubated in air in four different experiments was 57 ± 1. Peanuts incubated under 1% oxygen and 99% nitrogen contained only 17% free fatty acids. Free fatty acids percentage decreased slightly when oxygen was reduced from 21% (0.03% carbon dioxide) to 5% (no carbon dioxide). Percentage of free fatty acids decreased only slightly when oxygen was reduced from 20 to 5% with 20 or 80% carbon dioxide, but striking decreases occurred at the same levels of carbon dioxide with a reduction in oxygen from 5 to 1%. Percentage of free fatty acids with increasing levels of carbon dioxide with 20% oxygen were as follows: 20% carbon dioxide, 48%; 40% carbon dioxide, 37%; 60% carbon dioxide, 26%; 80% carbon dioxide, 13%; and 100% carbon dioxide, less than 1%.

Thus, storage under high levels of carbon dioxide and low levels of oxygen prevented peanuts from becoming moldy. However, the peanuts developed a very disagreeable odor that would probably make them unsuitable for human consumption. Thus, it appears unlikely that peanuts can be stored at high moisture and high temperature, regardless of the composition of the atmospheric gases. Research in progress indicates that more effective control of the mold problem might be obtained by storage at lower moisture levels at low temperature together with increased carbon dioxide and reduced oxygen levels.

Ecology and Aflatoxin-Potential Of Peanut Pod Fungus Flora

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Current interest in aflatoxin produced by *Aspergillus flavus* Lk. ex Fr. in peanuts and other crops has prompted cooperative research on peanut mycoflora in Alabama, Georgia, North Carolina, Oklahoma, Texas, and Virginia.

In the mycoflora studies, media used were rose bengal-streptomycin sulfate and Czapek-Dox. Fruits were surface-sterilized in 2% sodium hypochlorite and rinsed in sterile water. Pegs, shells, and kernels were plated separately. Appropriate dilutions of wash water of fruits were also used. The frequency of fungi as number per fruit was recorded after incubation and identification.

A. flavus was isolated infrequently from pegs, shells, and kernels of the peanut fruit on both media. Species of *Fusarium*, *Penicillium*, *Rhizopus*, and *Curvularia* were predominate fungi isolated from pegs, while species of *Rhizoctonia*, *Fusarium*, *Rhizopus*, and *Penicillium* predominated among those isolated from shells and kernels. Greatest frequency and number of fungal isolations occurred with dilution-plate studies of surface mycoflora of peanut fruits on these media. *Penicillium* spp., *Fusarium* spp., and *A. niger* predominated in the order named. Other fungi occurring less frequently included *Tricothecium roseum*, *Sclerotium bataticola* and species of *Curvularia*, *Cladosporium*, *Mucor*, *Rhizopus*, *Rhizoctonia*, and *Saccharomyces*. Soil type, location, and variety of peanut had no apparent effect on frequency and number of fungi isolated.

Aflatoxin assays showed predominantly B_1 and G_1. Aflatoxin occurred more frequently in shells than in kernels generally throughout the growing season and during the curing process after harvest. Assays of kernel and shell samples obtained 3 weeks prior to harvest showed the greatest amount of aflatoxin. No appreciable differences in aflatoxin occurred in samples taken from the top and bottom of the windrow during the curing process.

The fungi associated with peanuts and their relative prevalence tend to change as the fruits develop and mature in the soil. Further changes in incidence and prevalence of the mycoflora occur during the curing process after digging.

Macroscopic Anatomy Of The Female Reproductive Tract Of The Japanese Quail

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An investigation was conducted to determine the normal macroscopic anatomy of the ovary and oviduct of the Japanese quail.

The reproductive tract of the female Coturnix quail was found to be very similar to that of the domestic chicken. Eighty specimens ranging in age from one week to eight months of age were dissected. All of the birds used for dissection appeared to be in a healthy physical condition. The birds were killed by inhalation of lethal amounts of ethyl ether. In some of the specimens arterial and venous injections were made with latex to facilitate dissection of the vascular system. Dissections were made on both fresh and formalin-fixed specimens with the aid of a stereoscopic microscope.

The ovary and oviduct of the producing birds occupied most of the left dorsal two-thirds of the abdominal cavity from the thorax to the cloaca. The ovary was suspended by a short mesovarium from the first two lumbosacral vertebrae slightly to the left of the midline. The highly convoluted, dilatable oviduct, composed of infundibulum, magnum, isthmus, uterus and vagina was suspended from the left dorsal abdominal wall by the dorsal oviducal ligament. One border of the ventral oviducal ligament was attached to the ventral border of the duct while the other lay free in the abdomen.

The active ovary usually contained three to five large, yellow, vascular follicles and many smaller opaque ones. The cranial opening of the oviduct faced the ovary and formed the cranial portion of the thin walled, highly movable, funnel-shaped infundi bulum. The infundibulum narrowed and was then continuous with the thicker walled magnum. At the caudal extremity of the magnum was a narrow, translucent band which formed the junction between the magnum and isthmus. The isthmus was similar to the magnum but was smaller in diameter, shorter and joined to the bulb-shaped uterus. At the caudal end of the uterus was a short, thick walled, muscular vagina which after forming a sigmoid flexure entered the left wall of the cloaca.

Internally the oviduct presented a series of longitudinal rugae, which were very low in the infundibulum, increased in size and spiralled in the magnum and became smaller but straight in the isthmus. The rugae of the uterus and vagina were convoluted and presented a floral appearance. The uterus was the only portion of the tract that was pigmented.

The vascularization of the genital system was quite uniform though several minor variations were observed. Three ovarian arteries usually arising from the aorta supply the ovary, via the mesovarium. The oviduct was also supplied by three main arteries which were branches of the external iliac, sciatic and internal iliac arteries respectively. Venous drainage of the ovary and oviduct followed a pattern similar to that of the arterial supply and drained into the left common iliac vein. Innervation of the reproductive system was via the ovarian, sciatic and aortic plexuses, and nerve fibers originating from the pudendal nerve.

The female genitalia varied greatly from a small threadlike structure in the one week old bird to a large pendulous ovary and large, convoluted, functional oviduct in the producing bird. The ovary and oviduct remained in this enlarged state as long as the bird was in production. Upon cessation of laying the tract involutes to near infantile size. The investigation was supported in part by grant number PHS GM 12570-02 from the Public Health Service.

Comparative Effects of Nialamide And Nardil Upon Intestinal Serotonin

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A comparative study of two monamine oxidase inhibitors was carried out in order to further clarify the biosynthesis, metabolism and storage of serotonin or 5-hydroxytryptamine in the intestine.

One of the major problems in this type of investigation is to find an enzyme inhibitor that will act over a longer period of time, thereby allowing the investigator a little longer time span to study the physiology of the hormonal substance. The inhibitors chosen for this study were two of the newer hydrazine compounds, Nialamide (Niamid) and phenelzine sulphate (Nardil). Serpasil, a reserpinate compound was used to release the serotonin from its "bound" or storage sites.

In phase one of this investigation two hundred and seventy-five white female rats of a specified strain, age, and weight were utilized. The parameter measured was gastrointestinal activity exhibited by duodenal sections removed from the animals at specified times in the treatment sequence. All duodenal sections were perfused in a constant temperature bath, the motility picked up by a smooth muscle electronic transducer, followed by amplification of the signal and the resultant activity recorded by a polygraph in time scale. Later the recordings were analyzed and quantitated with a polar planimeter.

The results of the first phase of this investigation demonstrated that Nialamide was superior to Nardil in its ability to inhibit monoamine oxidase activity and thereby protect the biogenetic amine serotonin. In time scale Nialamide performed somewhat like Marplan, an inhibitor studied by other investigators in this laboratory. Nialamide, however, differed from both Nardil and Marplan in allowing longer protective action of serotonin.

Chemistry

Solubility Studies Of The Fe(III) di-n-Butyl Phenylphosphonate Complex

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An Fe(III) di-n-butyl phenylphosphonate complex is formed when a highly acidic solution of Fe(III) is extracted with a 5% w/v solution of di-n-butyl phenylphosphonate in kerosene. The solubility of this complex was studied at varying hydrogen and ferric ion concentrations by periodically determining spectrophotometrically the concentration of the ferric ion in the aqueous layer.

Upon extraction and determination of the concentration of the Fe(III) the aqueous layer indicated initially almost complete extraction and varying the amount of Fe(III) did not affect this initial extraction. However, the phenylphosphonate complex was found to be unstable upon standing in a strongly acidic solution. Thus, the aqueous layers from these various extractions turned yellow upon standing and became more yellow with increasing time. The increase in color corresponded to an increase in the amount of ferric ion present. It was concluded that this increase in the ferric ion concentration is due to the presence of the Fe(III) di-n-butylphenylphosphonate complex in the aqueous layer. The complex then apparently undergoes hydrolysis to release ferric ion.

Thus the Fe(III) and the hydrogen ion concentration was varied to study the effect upon the percentage extraction of the ferric ion or the solubility of the complex in the aqueous layer.

Solvent Variation Effects In The Solvolysis Of Cycloalkylcarbinyl Tosylates

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Comparative kinetic studies of the solvolysis of cyclohexylcarbinyl tosylate, I, cyclopentylcarbinyl tosylate, II, and their simplest acyclic analog, isobutyl tosylate, III, have been carried out in three solvents of varying ionizing power and nucleophilicity. The specific first-order rate constants at 100 C for the solvolyses of I, II, and III, respectively, are 8.03×10^{-4} min.$^{-1}$, 8.10×10^{-4} min.$^{-1}$, and 7.92×10^{-4} min.$^{-1}$ in absolute ethanol; 2.84×10^{-3} min.$^{-1}$, 4.55×10^{-3} min.$^{-1}$, and 2.98×10^{-3} min.$^{-1}$ in 80% aqueous ethanol; 1.50×10^{-2} min.$^{-1}$, 2.12×10^{-1} min.$^{-1}$, and 1.90×10^{-2} min.$^{-1}$ in formic acid. Whereas there is little variation in the reactivities of these compounds in ethanol, a solvent of relatively low ionizing power and high nucleophilicity, the spread in reactivities becomes pronounced as solvent ionizing power is increased and nucleophilicity is decreased. In particular, cyclopentylcarbinyl tosylate becomes substantially more reactive than isobutyl tosylate, but cyclohexylcarbinyl tosylate becomes slightly less reactive. This behavior is explained in terms of the relative potential for neighboring group assistance in those compounds. The availability of such neighboring group assistance in these systems is largely determined by conformational properties.

The Identification Of The Iron(III) Complexes Of Several Diesters Of Phenylphosphonic Acid

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When a saturated solution of $FeCl_3$ in 7 M HCl is extracted with a 5% v/v solution of di-sec-butyl phenylphosphonate (DSBPP) in kerosene, a third layer separates between the aqueous and organic layers. This yellow layer is assumed to be essentially pure Fe(III)-di-sec-butyl phenylphosphonate complex. Under similar conditions, complexes are formed with di-n-butyl phenylphosphonate (DBPP) and di-octyl phenylphosphonate (DOPP).

An investigation has been made of these complexes in an attempt to identify them on the basis of spectral data in the ultraviolet region. Previous work has been substantiated and additional information has been collected of the spectra in the ultraviolet region.

Nitrosyl Chloride Additions To Olefins. Synthesis Of Some Alpha-chloroketones

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Nitrosyl chloride adds smoothly to a number of acyclic and cyclic olefins to give either the monomeric or dimeric nitrosochlorides in near quantitative yields. These nitrosochlorides can be converted to the corresponding alpha-chloroketones in good yields by a very mild hydrolysis procedure using levulinic acid. Nitrosyl chloride can be generated as needed from a generator constructed from ground glassware. The nitrosyl chloride method for preparing chloroketones is particularly useful in the preparations of 2-chlorocyclopentanone (59%), 2-chlorocyclohexanone (63%), and 2-chlorocycloheptanone (93%), but is not as useful in those systems where the chloroketone product is thermally unstable or susceptible to further elimination reactions.

Fusion Of Carbon

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It appears possible to use coal as a source of carbon for a high temperature pyrolysis in order to separate the mirror image atoms of carbon. This chemical process would be followed by a nuclear process in which protons and neutrons, also previously separated by suitable pulsed magnetic fields, would fuse the carbon to nitrogen. The energy production per pound of coal is about 30,000 kilowatt-hours at 100 per cent efficiency for each pound of coal at 90% carbon. The electricity would result from an induction of the 12.5 Mev Kinetic energy directly. Pictures of the structure of carbon-12, carbon-13, and nitrogen-14 nuclei will be shown in color. At the present time no conditions for the pulsed magnetic field have been specified.

Nuclear Magnetic Resonance Study Of Intermolecular Exchange Of Some Linear Silazanes

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Intermolecular exchange under mild conditions of methylamino and anilino groups was observed in a mixture of bis(methylamino) dimethylsilane and dianilinodimethylsilane by proton magnetic resonance spectrometry. Equilibrium was reached within 24 hours, and at equilibrium the mixed species was present in a larger proportion than would be predicted for a random distribution.

The identity of the mixed species was confirmed by gas chromatography, infrared spectroscopy, and elemental analysis.

Geology

New Fossil Locality In The Butting Ram Sandstone Of The Talladega Group, Chilton County, Alabama

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Several types of fossils have been located in a relatively thin slate horizon in the predominantly conglomeratic and arkosic quartzite sequence comprising the Butting Ram Sandstone of the Talladega Group in north-central Chilton County, Alabama. The fossiliferous horizon occurs about 225 feet stratigraphically below(?) the gradational contact between the Butting Ram Sandstone and the Devonian(?) Jemison Chert, and is about 20 to 25 feet thick.

The fossils consist of molds and/or cores, so that internal features and details of ornamentation cannot with any certainty be determined. Tentatively, however, brachiopods of the families *Brachythyrididae*, *Chonetidae* and *Syringothyrididae*, one ostracode of the family *Kloedenellidae*, and several specimens of bryozoa of the family *Fenestellidae* (some recognized as genus *Archimedes*) have been identified. Several plant fragments have been noted. The age of the enclosing rocks, based upon the fossil assemblage, is thus Mississippian, Pennsylvanian or Permian.

Questions pertaining to the age assignment of the "overlying" Jemison Chert and/or the structural relationship between the Butting Ram and Jemison are logical aftermaths of this age assignment.

A Stratified Archaic Site In Lowndes County, Alabama

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During the spring and summer months of 1965, an ancient river terrace bordering the Tensaw Creek (Lo9) in Lowndes County was explored to determine its significance in the light of prehistory.

Evidence uncovered from thirty-two five foot sections produced a total of 2,478 pottery fragments and 565 stone objects which included 264 projectile points.

Studies of the materials recovered indicated that the site had been occupied since the very earliest days of man's appearance in what is now Alabama. Several Dalton type projectile points were found in the lowest levels, these implying a possible initial use of the site some 9,000 or so years ago. The site was almost continuously used by hunting-gathering peoples throughout Archaic times with Early, Middle and Late Archaic artifacts being represented at appropriate levels.

Final occupants involved Early Woodland peoples of at least three separate culture groups. The first of these produced fiber tempered pottery, mostly found in Level Two. In the top level (sections excavated in 6 inch levels), a form of sand tempered check stamped pottery featuring tetrapodal bases was found together with an as yet undefined plain and rocker stamped decorated ware which we have named Tensaw Plain and Tensaw Stamped, respectively. The Tensaw type pottery may relate to the Santa Rosa Swift Creek ceramics of the Florida Gulf Coast Early Woodland.

The Petrology Of The Auburn Dike

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The Auburn dike is a tholeiitic diabase dike with sub-ophitic to intergranular texture. Grain size ranges from 1 or 2 mm. near the center of the dike to about 0.2 mm. near the margins. Plagioclase makes up 45 to 60% of the rock and is zoned from oligoclase to calcic labradorite. Most of the plagioclase is also twinned. Clinopyroxene makes up 40 to 50% of the rock with augite dominating over pigeonite. Magnetite is the most abundant accessory and ranges from 2 to 4%. Small amounts of micropegmatite are present.

The diabases of Georgia and the Carolinas contain olivine in considerable amounts in contrast to the olivine-free diabase of the Auburn dike. The Auburn dike may represent a late differentiate relative to the Georgia and Carolina dikes, it may come from a different magma source, or it may reflect greater assimilation of wall rock material. The augites have a moderate optic angle, suggesting a high magnesium to iron ratio, not consistent with a late differentiate.

The Boydston Creek Bluff Shelter

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During the summer of 1965 the Boydston Creek Bluff Shelter was excavated by the University of Alabama under contract agreement with the Archaeological Research Association of Alabama, Inc. The site was located near Ider in DeKalb County, Alabama, and was similar to numerous other small shelters which line the streams of the Sand Mountain region. The site showed stratigraphic evidence of occupation beginning with the Dalton phase in the Tennessee Valley and possibly earlier, and continuing intermittently through the Mississippian stage. The heaviest occupation was in pre-ceramic times.

The Dalton occupation was represented by certain projectile points typed as Culbert and Greenbrier Dalton, Big Sandy I, and Hardaway. The antiquity of these types (about 9500 years old) has been previously demonstrated at the Stanfield-Worley Shelter. Fluted fragments, possibly of the Cumberland type, were also found mixed in with Dalton materials, raising to at least three the number of known stratified sites in North Alabama producing fluted points in this mixed context.

The early part of the Archaic stage was well represented at the site by characteristic pre-Shell Mound projectile points and uniface tools. The Morrow Mountain types were abundantly in evidence.

The shelter produced very few Late or Shell Mound Archaic traits, although only a few miles away extensive shell middens were being deposited at this time along the Tennessee River.

The ceramic occupation was evidenced primarily by certain pottery types common to the Guntersville Basin. The Wheeler Series was absent and Alexander sherds were rare. The dominant pottery types were the Middle to Late Woodland types known as Long Branch Fabric Marked and Mulberry Creek Plain. Associated with these were numerous milling stones and characteristic stemmed projectile points of various types. Sherds of the later clay-grit tempered McKelvey Series were not numerous, though numerous small to medium triangular projectile points were present.

The Mississippian occupation was evidenced by a few shell tempered sherds and projectile points typed as Madison and Jacks Reef Pentagonal. Presumably associated with the Mississippian occupation was a series of pictographs on the shelter wall which were similar to Southern Cult motifs at Moundville. These designs included the sun circle and bi-lobed arrow.

Apparently the shelter was always used more or less intermittently as a temporary campsite rather than as a permanent habitation area.

Drainage Density And Drainage Texture Relationships In Some Selected Fourth Order Drainage Basins Near Tuscaloosa, Alabama

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To study drainage network interrelationships between three adjacent physiographic provinces, the Coastal Plain, Valley and Ridge, and Warrior Basin, detailed morphometric analyses were made from topographic maps covering an area of approximately 1,000 square miles near Tuscaloosa, Alabama. Characteristics of fourth order drainage basins including stream order, stream length, basin area, bifurcation ratio, drainage density and drainage texture were determined.

Observed relationships indicate that there are no significant differences between these provinces except for drainage density and drainage texture. When these two parameters are plotted against each other, they form a straight line relationship with definite grouping of Coastal Plain and Warrior Basin points. Valley and Ridge points are not as consistent because of the greater variation in the underlying materials in that province.

If further investigations indicate that the statistical implications are consistent, analyses of drainage density-drainage texture relationships might be valuable in prediction of type of sedimentary material and structural attitude from topographic maps and aerial photographs with scales of one inch equals approximately one mile.

Mineralogical Notes Of Some Rocks Of The Talladega Series

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Mineral paragenesis of mildly metamorphosed phyllites and quartzites containing specular hematite, magnetite and small amounts of sulfide minerals were studied in polished section, thin section and polished thin section. The metallic mineral assemblages observed include:

hematite-pyrite
magnetite-pyrite
magnetite-chalcopyrite
hematite-chalcopyrite
pyrite-chalcopyrite
magnetite-hematite-pyrite
magnetite-hematite-chalcopyrite
chalcopyrite-bornite-hematite (?)
chalcopyrite-bornite-pyrite (?)
magnetite-hematite-chalcopyrite-pyrite

The assemblages chalcopyrite-bornite-magnetite-hematite and chalcopyrite-bornite-pyrite-hematite were not observed but may occur if bornite is a phase in these rocks. Principal non-metallic minerals included quartz, albite, microcline, muscovite and chlorite. The paragenetic sequence of the metallic minerals was generally: hematite-magnetite-pyrite-chalcopyrite. The principal non-metallic mineral assemblages, quartz-albite-muscovite-chlorite, and the inferred presence of pyrophyllite and paragonite justifies classification of the gray ore rocks as low-rank greenschist facies (quartz-albite muscovite-chlorite subfacies). Evaluation of paragenetic data in the light of recent experimental information suggests a maximum vein mineralization (or metamorphic) temperature of 228° C-675° C, but a probable range of 400° C-560° C.

Origins Of North Alabama Folk Houses

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The folk houses of North Alabama reflect very old traditions of form and construction, evolving from the rectangular, gable roof, single room log house of the pioneer period. The form of this house could have been introduced from any of several European countries but the technique of horizontal log construction which became dominant on the eastern frontier was a German introduction from Western Europe where it had been in use since the Mesolithic culture period.

Larger types of single log houses were built to obtain more living space. At least three distinctive double-houses evolved on the Virginia-North Carolina-Tennessee frontier as a solution to the problem of enlarging upon existing single log houses by building: a new single log house at the chimney side, or, at the clear side with the walls abutting, or, at the clear side but separated by an eight to ten foot wide passageway. All three were houses with two log rooms. The first had a center chimney and the other two had side chimneys.

Each of these arrangements had its later counterpart in frame and weatherboard construction. The double-house with the central passageway was the most common folk house of North Alabama and was abundant throughout the South. These "log cabin" derived house types, together with two more recent introductions, the square, pyramidal or hip roof house and the smaller bungalow, dominated the North Alabama rural landscape until the mid-twentieth century.

Forestry, Geography, And Conservation

Fiddleback And Quilted Figures In Wood

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Curly and blistered figures in wood occur occasionally in various maples, ash, walnut, yellow poplar, and rarely in other species. Certain variations of these figures that are regular in appearance are called fiddleback or quilted figures.

The fiddleback figure, long used in musical instruments, is caused by regular undulating grain that exhibits a corrugated appearance on radial surfaces, but is essentially flat on tangential faces. When fiddleback-grained wood is surfaced, figures appear as a series of horizontal, parallel stripes. These figures change with the direction of viewing.

The quilted or blistered figure usually is not as regular in appearance as fiddleback and is exhibited on the tangential face; the radial face is essentially flat. This figure appears as a series of convex intersecting areas on one side of the wood surface and as concave areas on the other.

Partridge Wood—A New Concept In Wood Utilization

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Oak wood that exhibits a characteristic lace-like pattern of alternating discolored solid portions and empty pockets, a result of partial degradation by the fungus *Stereum frustulosum* (Pers.) Fr., is known as "partridge wood." This particular type of degraded wood, although known for more than 50 years, only recently has been shown to be suitable for use as veneer facing on small wood products.

Several items constructed from partridge wood are illustrated.

Land Use On The Clay Soils Of The Alabama Black Belt

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Data are now available which permit the correlation of soil type and agricultural land use in the Black Belt geographic region. These data were obtained on a two percent sample basis in 1958 during the National Inventory of Soil and Water Conservation Needs.

By expanding the acreages of only those samples located within the Black Belt area of Hale County, Alabama, the data indicate that within Hale County the Black Belt comprises an area of approximately 103,000 acres. Of this, 59,000 acres (57.3%) are devoted to pasture, 34,000 acres (33%) to forest-woodland, and 10,000 acres (9.7%) to cropland.

Using soil acidity as a criterion, the calcareous soils (such as Sumter Clay) are more exclusively devoted to pasture than are the acid soils (such as Oktibbeha-Vaiden Clay). Factors other than soil acidity appear to be an influencing factor where relatively large areas of one type of acid soil (Eutaw-Mayhew soils) are devoted to pasture.

Physics And Mathematics

Combined Stress Results For Thermoplastics

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Tension-tension and tension-compression stress and strain data are reported for acrylic and nylon tubular specimens tested at room temperature. Combinations of axial loads and internal fluid pressure were applied to the tubes in a proportional manner by apparatus which is actuated by means of a universal testing machine. In order to minimize viscoelastic effects, data were obtained for effective strain rates of equal magnitude. For an effective strain of one percent, the stress results correlated quite well with the octahedral shear stress or maximum distortion energy theories. With increasing strain, the stress behavior became increasingly anisotropic and more complex theories were required to predict the combined stress behavior.

On Sound Propagation And Acoustic Focusing

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In the beginning, the problem of acoustic ray propagation and the phenomenon of acoustic focusing is being explained. The problem is associated with propagation of acoustical noise created during static testing of big space boosters.

The determination of focusing by electronic data processing is being discussed. The problem is narrowed down to determine the minima of X_s (the end point of the returning acoustic ray) as a function of the elevation angle Θ. Since this function is complex and displays irregularities, criteria were developed to distinguish between real minima associated with focusing and unreal minima.

The frequency of focusing as function of the azimuth is being displayed for stations in the Southeast United States and in Europe. Further, an areal distribution of focusing is being discussed for the climatic regime in the Southeast United States. Three major types of sound speed profiles in the first 3 Km are being shown for two groups, favorable and unfavorable to focusing.

Finally the atmospheric conditions leading to returning rays in a distant area from the Huntsville Test Facility are being explained.

Oxidation Characteristics Of Vapor-Plated Tungsten

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In recent years the process of vapor plating has gained some prominence as a means for fabricating complex shaped hardware from tungsten. While the oxidation kinetics of this metal prepared by conventional metallurgical means has been rather well explored, tungsten prepared by vapor plating has never been systematically investigated.

Rate constants for oxidation in air were established for the vapor plated metal at 100° intervals from 600° to 1,000° C, using a recording balance. Linear and parabolic activation energies were calculated. Comparisons were made between the oxidation rates of conventional sheet tungsten and vapor plated tungsten, and between humid air and dry air as corroding media.

Langmuir Probe Studies Of A Gas Discharge

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A Langmuir probe was used to investigate the electron temperature, the relative electron density, and the space potential in a low density glow discharge in nitrogen, and to determine the effect, if any, of the probe on the radial distribution of the axial current. The discharge was produced between two parallel plate electrodes, one being of multi-ring construction, and was maintained in a geometry such that the radius of the electrode was considerably greater than the electrode separation. The distance from either electrode surface to the conducting walls of the confining vacuum chamber was also large compared with the electrode separation. The discharges were operated at pressures between 0.5 and 1.0 Torr with a maximum current density of 0.25 ma cm^{-2}.

The voltage-current plots of the probe revealed a hysteresis effect throughout the range of the plots. As yet no satisfactory explanation has been proposed. The space potential was found to decrease slowly with increased distance from the anode, passing through a minimum in the Faraday dark space, and increasing slightly thereafter until a maximum was obtained in the brightest region of the negative glow. Beyond this point the potential drops sharply upon approaching the cathode. This result appears to agree qualitatively with recent work by Medicus.

The electron density was found to be greatest in the negative glow region and to decrease rapidly toward the anode in the Faraday dark space, while the electron temperature decreased only slightly in the same region. Each probe position and bias was found to disturb the radial distribution of the axial current.

Neutron Reaction Studies Of Nd^{142}

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Several properties of the production and decay of Nd^{141} from the nuclear reactions $Nd^{142}(n,2n)Nd^{141g}$, Nd^{141m} have been studied using 14.7 MeV neutrons from the $T(d,n)He^4$ reaction. The isomer Nd^{141m} is a 760 keV excited state which decays directly to the ground state by gamma emission and the radioactive ground state decays by electron capture and positron emission to Pr^{141} whose ground state is stable. The Nd^{141} isomeric yield ratio, the half-lives of the isomerie state and the ground state, the positron branching ratio of the ground state decay and the $Nd^{142}(n,2n)Nd^{141}$ cross section were measured using a NaI(Tl) scintillation spectrometer. The measured values were 0.689 ± 0.069, 64.7 ± 1.3 sec, 2.42 ± 0.09 h, 2.73% ± 0.27% and 1,650 ± 165 mb, respectively. An upper limit on the ratio of the $Nd^{142}(n,\alpha)Ce^{139}$ cross section to the $Nd^{142}(n,2n)$-Nd^{141} cross section was determined to be 1.5×10^{-3}. The spectrometer photopeak efficiency as a function of photon energy was measured in an absolute manner using a set of gamma sources whose disintegration rates were known to within ± 5%.

A high resolution study of the decay scheme of Nd^{141} to Pr^{141} was made using a Ge(Li) detector with a resolution of 0.75% at 1 MeV. Gamma rays were observed with energies of 1.293 MeV, 1.146 MeV, 1.126 MeV and 0.145 MeV to within ± 1 keV. The results support the conclusions of a previous study for the existence of a level in Pr^{141} at 1.126 MeV.

Determination Of P/β Ratio For Plastic Scintillator

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The relative response of organic scintillators to energetic particles has been studied by several workers. The energetic particles are usually supplied by the use of a radioactive source or from an accelerator.

In the present experiment the proton-to-beta ratio was measured for Pilot B plastic scintillator (manufactured by Pilot Chemicals, Inc., 36 Pleasant Street, Watertown 72, Massachusetts) for protons of energy 2.64 MeV and electrons of energy 0.639 MeV. The protons were produced by allowing 3.91 MeV neutrons produced from the $D(d,n)^3He$ reaction to scatter through 55° (lab angle) while the electrons were produced by allowing ^{60}Co gamma rays to scatter through 55° (lab angle). The P/β ratio is equal to $S_P/E_P/S_\beta/E_\beta$, where S_P represents the peak channel of the distribution resulting from the scattering of neutron and E_P is equal to the energy of the recoiling protons. S_β represents the peak channel of the distribution resulting from the scattering of ^{60}Co gamma rays and E_β is equal to the average energy of the Compton electrons produced. Using the above procedure the P/β ratio was found to be 0.26.

Previous determination of the relative response of plastic scintillators for energetic particles include measurement of the α/β ratio, but not the P/β ratio. It is of interest to compare the P/β ratio for anthracene and Pilot B as they have approximately the same atomic number, both being hydrocarbons of related structure. From Taylor *et al.* the P/β ratio is found to be 0.34 for 2.64 MeV protons and 0.639 MeV electrons.

Industry And Economics

The Mainsprings Of Motivation In Unskilled Production Work Groups In A Large Scale Industry In Alabama

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The purpose of this study was to examine a number of problems and hypothesis influencing unskilled production employees. In this study the unskilled group includes those whose work assignments require considerable physical energy but no special skills and whose duties involve routine tasks which are normally performed under close supervision. Approximately 85% of the unskilled help are Negro employees; the remaining 15% are Caucasian.

Interviews were conducted with over 95% of all plant supervisors. Non directed and directed interviews were used in interviewing employees in the unskilled group. The number of safe generalizations in the area of motivation is much smaller than many professionals and practitioners would care to admit. The term Motivation is frequently referred to as drives, instincts, purposes, impulses, motives, and proposed explanations of the behavior of people.

Preliminary discussions with production supervisors resulted in a number of speculations and comments about unskilled production workers. Nearly 65% of the supervisors remarked that they believed the unskilled employees to be primarily motivated by money or financial rewards. About 25% stated that in their opinion employees were primarily motivated by the need to hold their jobs. The remaining 10% opined that there was more to motivation than money and security, but that they did not know what it would be unless it was the employee's desire to "get ahead."

Supervisors were asked to record the most frequent complaints of their unskilled workers. These complaints were analyzed in terms of their impact on the organization, shop morale, productivity, quality and cost aspects. Additionally the complaints were related to the total environmental system.

Other aspects of motivation in this plant were studied including: money as a motivator, assumptions about human behavior, leadership preference, additional effects of the environment, a brief analysis of employees requests as related to their complaints.

The unskilled worker for the most part appears to have adjusted to his routine wearisome, surface attention job. It was concluded that this work group derives little if any real satisfaction from their jobs per se. This is due in part to the prevailing environmental culture, the paucity of relatively high paid unskilled jobs in the area, seasonal problems of unemployment, poverty, disintegration of family life, and considerable negation of the generally ascribed success oriented values such as responsibility, duty, job accomplishment, education, drive and ambition. The majority of unskilled workers expressed relatively low level aspirations for themselves but impressively high level aspirations for their children. The plant supervisors reported that approximately 80% of their unskilled employees do not require either threats or disciplinary action in order to get them to do their assigned job properly.

Solving motivational problems in our changing society will require continuous behavioral research. Further studies concerning this topic could be directed toward the semiskilled, skilled, and highly skilled production employees in southern industries.

Consumer Shopping Travel Behavior—A Spatial Analysis

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The modern functions of new or improved highways include cohesion and economic development but other functions served include relieving traffic congestion and more important facilitating the safe and efficient movement of goods and persons in large quantities at relatively high speeds from given origins to desired destinations. The purpose of modern highways therefore include expeditious and efficient movement between locations to permit social and economic transactions and also to serve human values which may be unrelated to economic criteria.

Spatial separations are apparent in the simplest economy as well as in a highly specialized economic and social organization characteristic of our present society. The consumers' travel demand characteristics will be affected by public investments on the supply side. These investments can and do include the modern highway which in turn can be considered as both a means and an end for satisfying consumer wants, as well as contributing a larger range of choice to the highway user.

Studies of travel behavior are broader in nature than abstracted travel demand models which are concerned with frequency and generation characteristics of motor vehicles. Highways solve problems as well as create them. Increased attention must be given to explaining and predicting total travel behavior in urban areas and within intra-markets in urban areas where people and business firms engage in production, exchange, and in transactions which create massive congestion problems.

Shopping travel behavior analysis must include detailed consideration of forces that pull or push people in urban areas to reorganize their activities by moving, for instance, to new supply points because of time benefits and improved accessibility. If human values of increased convenience, comfort, pleasure, and happiness are satisfactory goals for shopping institutions, and if sufficient price alternatives exist among institutions, then public investment should be tailored to achieve similar goals.

Who Uses The State Employment Service?
A Profile For Lee County, Alabama

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This study of the characteristics of the clients of the Lee County Employment Service office is based on a sample of 485 records. Most of the persons studied, 362, were seeking general employment, but 41 were looking for work as maids and 82 were trying for jobs with the United States Rubber Company.

The investigation revealed that the Opelika Employment Service Office serves two broad classes of applicants: a group of white workers generally well trained and educated and including many women who are seeking better jobs, and a larger group of untrained and uneducated whites and Negroes who are searching for work or hoping for unemployment compensation. Interestingly, the records show that a majority of all applicants have not drawn unemployment compensation.

The Negro applicants studied compete unfavorably with the white applicants. The Negroes are generally older, more likely to live in rural areas, and to have dependents, and are less apt to have access to a phone or ready transportation. They have less education, and fewer of them have special business, technical or even military training. More Negroes than whites experience unemployment and for longer periods. Their wages are lower.

Nevertheless, Negro workers, especially the women, do not turn to the Opelika Employment Service for help as readily as do white workers. Possibly the Negroes do not realize that as high a proportion of Negro applicants as of whites receive job referrals through the Office and that a higher proportion secure some type of employment as a result.

The study shows that the Opelika office is in touch with a large group of workers who could benefit by the education and training offered by the new national manpower programs and by the state technical schools. The experience of these workers further indicates that training and education are associated with the reduced incidence of unemployment.

Some Uses Of Markov Chain Analysis In Studies Of Business Concentrations

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This paper deals with the prodecural steps necessary to obtain an initial transition probability matrix of a Markov process by minimizing the absolute deviations in sample data. The procedure outlined is especially useful when no micro data are available and the shifts of concentrations in the micro data are estimated from macro or aggregated data by use of a linear programming model.

This model was applied to estimate the shifts in number of employees per retail firm over time. The results obtained were reasonable estimates of trend, but the estimate of the transition probability matrix was not consistent with economic logic. Sample size was the minimum possible and this fact points up the difficulty of using census data for this estimating procedure.

Science Education

The Use Of Elementary Science Study Materials To Enrich A Course In Science For Elementary Teachers

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An inspection carton of five units prepared by the Elementary Science Study was obtained recently and used in a Science for the Elementary Teacher course. After a few brief introductory lectures, the class was divided into groups of about three students. Each group selected one of the units to present to the class as if they were teaching at the elementary level. The material is planned for the elementary students to use kits of materials individually or in small groups but we had only one kit for each unit so we used it as demonstration material with some participation by the members of the class in each demonstration. The class consisted of 17 students, mostly juniors with one boy and one lady of 63. It seemed to be an average class but there was more than average interest after we started to use the new materials.

The first group worked with the unit called "Kitchen Physics" (5-8 grade level) and selected a part of it to present to the class. The unit is assigned to occupy about 35-45 classroom hours. One of the most interesting of the parts was a study of the "grabbiness" of plain and soapy water. The tensionometer was a balanced stick supporting two paper cups using small washers for weights. On one end of the stick small squares and circles of plastic were hung and allowed to touch the water surface. The weight needed to pull away the flat pieces was measured in the number of small metal washers placed in the cup at the other end of the stick. A graph was made to represent results. An attempt was made to introduce ideas and observations without the use of difficult terms and familiar words were used when possible. Other demonstrations included the familiar ones such as placing a drop of soap solution in a floating loop of thread, observing the piling up of water above the rim of a glass, and the movement of talcum powder floating on the surface when a drop of soap solution was placed in the center of the container. Another major part of this demonstration was a study of absorption of water by blotters and the rate of evaporation under several conditions—one of them having the strips covered with plastic.

The student used several liquids such as alcohol, chocolate milk, and furniture polish to study rates of evaporation and it was interesting to observe that we also obtained a fair separation of furniture polish by paper chromatography. The beading effect of several liquids was studied using a plastic bottle with several stoppers with varying sized holes in them and a hole in the bottom of the bottle. Eight m.m. film loops are also available for each of these units to be shown *after* the student has done the work and for the help of the teacher.

For grade level 4-6 the Unit "Small Things" is designed to require about 35-45 classroom hours so the students demonstrated only a small part of it. The use of the small microscope in the kit which costs less than a dollar was of considerable interest to all the students. They found that it worked fairly well at low power. As in all these units the plan is to provide materials for individual or small group work. One of the first exercises is to compare the size of an onion cell with a human hair and then the student is led to the idea that other things are made of cells. Several crystals are introduced to help the student to discover that regular shaped materials are not always cells. We also used our regular microscope and reviewed the making of a hay infusion, use of stains, making a wet mount and related activities. The film loops accompanying this unit are the best ones I have seen on this subject.

The unit which promises to be one of the most interesting is the one called "Behavior of Mealworms." In this unit a clean, odorless larva is observed and its behavior studied. The students devise experiments to measure and classify their observations, make charts, keep records, ask questions, discuss results, predict and draw conclusions. Most of their experiments center on ways to test the unfamiliar animal's sensory perception: How do mealworms back up? How do they explore a box? Follow walls? Find their food? What children learn about mealworms is incidental to what they find out about evaluating evidence based on observation, classification, measurement, and control of variables — in short the analytical approach to investigating animal behavior.

Growing Seeds is the title of a unit for grades 1-3 and is designed for about 6-8 hours of classroom time. My students started growing the seeds at home and then brought the plants to class for the other students to observe. In addition to observing the seeds germinate the students measure the growth in an unusual way. Each child grows a corn plant and cuts a strip of paper to measure the height every day. The collection of strips becomes a "graph" of the plant's growth and a source of answers to questions raised by teacher and children about rate of growth. By comparing and trying to interpret one another's graphs, the children begin to appreciate and understand the value of ordered arrangements. Two excellent film loops using the time-lapse technique show the growth of plants and one of them shows it in a graphical manner.

In conclusion, this ESS material lends itself to teacher preparation. One of the most important ideas we have tried to get across was that the elementary teacher should let the student "do" the work himself instead of blindly following a cookbook in the direction the teacher wants to go. If the child is allowed to "fool around" some with the equipment and a few ideas he may learn a great deal more than if he follows the exact directions of a book. Perhaps we might even try such an approach at higher levels — who knows what may happen?

The Biochemical Fuel Cells

JOHN W. HANSEN and HUGH FINLEY, JR.
Dothan, Alabama

Realizing that our present sources of energy, such as coal, oil, natural gas and hydro-electric power will be exhausted in the foreseeable future and that atomic power has its limitations, an energy source other than these would seem imperative if civilization, as we recognize it, is to survive.

Energy in the form of solar radiation is constantly being received, dissipated and renewed. Although the total amount of this energy is enormous, its distribution over the earth's surface is of a like magnitude.

Efforts made to concentrate this energy other than by the process of photosynthesis have not met with much success. It was our objective to adapt this process, so efficiently utilized by algae, to a level of practical utility.

By the means of fungal decomposition of organic waste matter a supply of carbon dioxide for algae metabolism was obtained. The cost of producing this gas had been an obstacle in algae culture.

Co-ordinating algae and fungi together with other component parts of equipment the fungi-algae biochemical fuel cell was conceived. Our research on this type of cell covered a period of approximately 3 years and the number of hours per day did not average over 2. The invested capital did not exceed two hundred dollars. We received no aid from any private or government grants.

Through this research we were able to improve the cell's electrical efficiency from the original which required the most delicate electrical measuring instrument to indicate a voltage, to the present level of 1 to 1.25 volts per cell. It is now feasable to provide electronic power with these fuel cells.

Research on the following items should prove fruitful:

1. Breeding more efficient strains of algae and fungi and selection of mutants.
2. Improving the electrode efficiency of the cell.
3. Improving on the relation of the cells integral factors, such as the design of fungal compartment and ionic bridge and supplying the algae compartment with a means of circulating the algae culture and the supply of carbon dioxide gas.

Biochemical fuel cells are also a source of algae which may be used as food. They offer a means of transition of carbohydrates, cellulose and hemicellulose to protein feed with a nutritional level about par with beef.

Departmentalization In The Junior High School, With Emphasis Upon The Sixth Grade Curriculum

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The sixth grade of the Troy Junior High School, Troy, Alabama, has found that its program is enhanced by the coordination of its schedule with that of the school. The elementary style (one teacher all day) plan has been adapted to accommodate the security of one teacher with the resourcefulness of a "specialist."

In the science program, the teacher is able to equip the "science-homeroom" with the science equipment that is usually scattered among several classrooms, thus, the pupils gain the benefit of a more varied program and a more consistent one.

In-service discussions make it possible to co-ordinate the sixth grade program with that of the seventh grade, etc. The fifth grade teachers also send information as to how much or what they have studied. This information is used to aid in preparing the program for the class. The continuing growth in knowledge for the class in science is our goal.

The immediate adaptation of the new *Alabama Course of Study for Grades 1-6* and other materials new to the prescribed areas will aid in the up-grading of the science program for next year and for the future.

Numbers, Units, and Dimensions: Report Of An Experiment

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Thirty-eight, three-criteria matched pairs of eighth grade students were involved in a program in which the experimental group was taught an intensive two-week introductory unit on the topic: "Numbers, Units, and Dimensions." The control group was not taught such a unit. At the end of the two-week period, both groups were taught their regular six-weeks-long unit on selected topics from physical science. At the end of the physical science unit, both groups were tested for concept mastery.

The Null Hypothesis (N_o) which was tested was: "There is no significant difference in concept mastery between a group which has been taught a short unit on 'Numbers, Units, and Dimensions' and a group which has not been taught such a unit."

A single-tailed t test was applied and a significant difference was found at the $\alpha = 0.05$ level of confidence.

RESULTS:

1. The Null Hypothesis was rejected.
2. Students who were exposed to the specialized unit on: "Numbers, Units, and Dimensions" achieved significantly higher than the students who were not so exposed.
3. All of the teachers who were involved in the experiment stated that they felt that the students who had taken the introductory unit on "Numbers, Units, and Dimensions" better understood the material in the physical science unit.
4. All of the teachers who were involved in the experiment stated that they would probably continue to offer the specialized, introductory unit to future classes.

Social Sciences and Anthropology

Changes In The Structure Of Agriculture In The Mobile-Alabama-Coosa River Basin

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Marked changes have occurred in agriculture in the past two decades. Changes in agriculture have nowhere been more evident and their effects more basic in nature than in the South. Alabama and Georgia, and the Mobile-Alabama-Coosa River Basin (MACRB), are prime examples of southern agriculture and of the structural adjustments that are occurring.

A cross-section of Alabama agriculture can be found in the Basin. Changes within the Basin will generally reflect changes within the State. The forces that have affected agriculture in the Basin have been both farm and nonfarm factors. The area's dependence upon its agriculture for economic stability is lessening. It is becoming simply a sector of the Basin's total economy. Farm numbers declined almost 50% from 1945 to 1960. The average farm size was 93.8 acres in 1945. Average size increased to 152.7 acres in 1960. Increasing farm size and improving productivity emphasize that Basin farmers are adopting scientific and technological improvements.

If the Basin's agriculture is to compete with that of other sections, it must continue to grow as a commercial business industry. It can be expected that agriculture in the MACRB will continue to experience alterations in structure as it develops as a sound economic sector of the Basin's total economy.

Attitudes Of Alabama's Rural Poor

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National attention was focused in 1964 on the poor and poverty stricken in the United States. President Johnson's 1966 *Congressional Message on Agriculture* placed specific emphasis on the rural poor. Data from a sample of 455 rural households was available from a 1959-60 study in five Alabama counties (Clark, Fayette, Monroe, Montgomery, and Tallapoosa) classified as low-income by the USDA. Household heads and homemakers had been interviewed to obtain information of the extent and nature of the low-income situation in these areas. Only 30% of the sample households had total family incomes over $4,000 while 28% had incomes under $1,000. Discussion was limited to households with family incomes less than $4,000.

It was found that nonwhites were twice as likely to have subsistence incomes under $1,000 as were whites. Similarly, heads and homemakers less than 45 years of age were almost twice as likely to represent low income households ($1,000 to $4,000) than subsistence income households. Reactions to household income were analyzed for subsistence and low-income and for white and nonwhite households. Consideration was given to evaluations of income adequacy and the nature of any necessities unmet because of insufficient income. Further consideration was given to attitudes toward life as indicators of different reactions to being poor.

Income differences were consistently reflected in the dependent variables considered. This consistency was not found, however, between whites and nonwhites. Rather distinct differences were observed on some variables while little or no difference existed on others. From this it was concluded that inadequate income has a similar impact on members of both races in Alabama's depressed rural areas and that social factors unrelated to income account for those differences that appear.

Changing Farm Real Estate Values

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Increases in per acre farm real estate values in recent years have been greater in Alabama and the Southeast than in the rest of the continental U.S. Average value per acre for Alabama farm real estate in 1965 was $128 compared with $146 for the U.S. Alabama farm real estate value per acre has more than doubled since 1955. Increased values for farm real estate have far-reaching implications for farmers, investors, and consumers.

The classical explanation of increasing farm land values has been higher productivity. Correlation between per acre farm income and real estate values was reasonably good until 1950. Since 1950, value has continued upward while net farm income per acre has declined. Farm real estate values in recent years have been influenced more by location factors than by farm productivity. Location factors include roads, highways, cities, industrial, and recreational developments. With continued population growth it appears likely that location factors will, in the future, influence farm real estate values more than the level of flow of annual income from farm land.

Medical Sciences

Persistance Of Histamine Insensitivity Of The C3H/An Mouse After Massive Doses Of Methopyrapone

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Some inbred strains of mice are approximately 100 times as sensitive to histamine as other strains even after uniform histamine sensitization with lymphocythemia producing dosage of aqueous pertussis vaccine. Since adrenal glucocorticoids can protect against histamine effects, one of the parameters within which strain variation could alter histamine sensitivity is adrenal glucocorticoid response to histamine. The relatively sensitive young adult male RML mouse becomes approximately 28 times as sensitive after adrenalectomy. In the present investigation adrenal glucocortieoid blockade with the 11-beta-hydroxylase blocking agent Methopyrapone (Su-4885) at maximal (nearly anesthetizing) dosage failed to measurably alter the response of the very insensitive C3H/An mouse to a high dose of histamine phosphate. Aided by grant No. T-302A from the American Cancer Society.

Magnesium Deficiency And Cortisone Treatment In Mice

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Clinical signs and tissue changes were observed in mice fed a magnesium-deficient diet. A portion of the magnesium-deficient mice was treated with subcutaneous injections of cortisone acetate. Hyperexcitability with occasional convulsions, which previously has been shown to be characteristic of magnesium-deficiency in rats, occurred in the magnesium-deficient mice. Although temporary peripheral vasodilation is a regular sign of magnesium deficiency in rats, no such sign was observed in the mice. Magnesium-deficient mice that were treated with 1.0 mg/mouse/day of cortisone acetate for either 12 or 16 daily injections developed severe tissue damage which was not observed in untreated mice fed magnesium-deficient or nutritionally complete diets. The principal histopathologic changes caused by the cortisone were degeneration and calcification in skeletal muscle, liver, and heart muscle. Although the cortisone caused tissue damage, it was beneficial in decreasing the number of convulsive episodes and prolonging average survival time in mice when administered daily beginning with the administration of the deficient diet.

Cleft Lip And Cleft Palate In Iceland

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A statistical study of the incidence and familial occurrence of cleft lip and cleft palate was conducted in Iceland during the summer months of 1963 and 1965. The excellent health records and the homogeny of the Icelandic people made a study of this kind highly desirable.

Three case sources were utilized in the study: birth records, maternity records, and surgical records. The period 1956 to 1962 was chosen as the study period, as the available records showed the greatest degree of reliability following the year 1955. During this period one child with cleft lip and/or palate was born in every 485 births. This incidence was, as far as could be determined, the highest incidence reported in any Caucasian nation.

Pedigrees were established for 80 cleft patients. The frequency of cleft among close relatives of the probands was more than four times that of the general population. The occurrence of cleft among the close relatives on the mother's side of the family was four times as frequent as on the father's side.

Chemical Modification Of Immunoglobulin Structure

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IgM(19S) was obtained from a patient with Waldenstrom's Macroglobulinemia and purified by $(NH_4)_2SO_4$ percipitation, ultrafiltration, and fractionation on a Sephadex G-200 column. This protein was subjected to tryptic digestion, cyanogen bromide cleavage, reduction and alkylation without denaturant, and poly-alanylation in order to provide basic information for the study of H chain structure.

As indicated by gel electrophoresis at pH 8.6 and antigen-antibody precipitation on Ouchterlony plates, at least four fragments were produced by tryptic digestion. Two of these showed partial antigenic identity with the native 19S. Cyanogen bromide cleavage produced two major components, each of which retained antigenic properties. Reduction and alkylation according to procedure of Miller and Metzger, produced H and L chains, with the H showing partial identity with native 19S. Poly-alanylation produced a larger molecular weight, modified protein which retained antigenicity.

These results show that there are many antigenic sites on the macroimmunoglobulin which retain their antigenicity despite modification and that these fragments can be separated for detailed structural analysis.

A Design Of A Multi-Use Experimentation Area With Adjoining Laboratory Animal Rooms

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The number of laboratory animals being used in medical research projects is increasing, but with centralized animal facilities in Medical Research Centers charging board for housing of animals, the number of animals per experimental colony is decreasing. With the trend toward smaller colonies, there is a need for rooms of smaller size in order that space may be utilized more efficiently. With this in mind a unit including a laboratory (7′ × 23′) and 10 (7′ × 8′) animal rooms that can accommodate a variety of research projects was designed. This (21′ × 40′) area is being constructed as part of the eighth floor addition to the Research Building of the University of Alabama Medical Center.

The laboratory area and animal rooms will contain the following items; A. Operating table; B. Surgical lamp; C. Cabinet for supplies; D. Sterilizer; E. Sink; F. Refrigerator (under the counter type); G. Air, gas, suction, and water; H. Schedule board; I. Floor drain; J. Thermostat (one in each room); K. Doors (each will contain an 18″ × 18″ unbreakable window); L. Electrical plug (110 volts with water proof cover). Cages will be moved in the rooms as needed. The walls will be constructed of glazed tile. Each individual room will contain a thermostat, air intake and exhaust. There will be fifteen changes of air per hour with no recirculation. The animal rooms will have negative pressure in relation to the halls. This design could be utilized by Institutions planning laboratory animal rooms in the future. If this was the only animal area available one room could be used for storage and supplies, and another for cage washing. The above plan could be divided in half and the area would only be 21′ × 20′, and it would provide five animal rooms and the laboratory area. This work was supported by USPHS NIH grants FR-5349 and FR-5300.

Isolation and Numeration Studies Of Sewage-borne Nematode Populations

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Because one step in a suspected human enteric disease transmission system involves the ingestion of the pathogens by sewage-borne

nematodes, it was desirable to investigate nematode populations in sewage treatment plants representative of the three prevalent treatment processes and to study the effect of those processes on nematode concentrations.

Statistically satisfactory sampling techniques and counting experiments were developed and were used during the major portion of a year to routinely evaluate populations in the three selected plants.

With influent population densities ranging upward to 800 nemas per liter, only the trickling filter plant evidenced the consistent, significant removal of nematodes as the sewage passed through the plant. The other consistent phenomenon observed was that populations were always reduced during passage of sewage through sedimentation basins.

The sampling methodology developed will be particularly helpful to others who wish to investigate sewage-borne nematode populations.

Engineering

Digital Models For Control System Applications

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In this work, 3 techniques for the synthesis of a network with a given transfer function are described. The synthesis techniques, which are based on approximation methods using sampled inputs, are listed and described as methods I, II, and III. All 3 techniques are derived through the use of the convolution integral with each method, I, II, or III, originating from the different approximations of the input.

The purpose of this study was to determine the feasibility, and the desirability, of the digital implementation of a network with a given transfer function. The approach taken was entirely general and allowed the techniques developed to be used in the realization of any type of transfer function. However, of the 3 techniques presented, the more advantageous technique will depend upon the specific problem under consideration.

In synthesizing a particular transfer function, the required amount of circuitry for the implementation of the network will determine the technique used. As will be noted, all 3 techniques require a varying amount of logic circuitry for the implementation of a network.

Circularly Polarized Electronically Scanned Tracking Antenna

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A common method of scanning the beam of a tracking antenna is to move the antenna structure mechanically. This method has the disadvantages of requiring physical movement of a relatively large mass, and of requiring the usual maintenance at the antenna site.

An antenna may be scanned electronically if it is composed of a number of elements between which the phase of the radiated energy may be varied. This method has the advantages of requiring no moving parts and of offering the reliability of electronic components.

A test antenna was constructed which could be scanned electronically. The antenna consisted of thirty-six elements arranged in a matrix. Each of these elements had a crossed-slot as the radiator. Each of the crossed-slots was backed by a microwave cavity which was dielectric loaded in order to reduce the physical spacing between the radiators. The crossed-slots were employed to achieve elliptical polarization. The cavity allowed the proper excitation of the slots.

The cavity has a unique feed system in that two perpendicular loops are excited from a single input; one is excited directly, the second is parasitically excited. This technique allowed the excitation of two orthogonal modes in the cavity with a single input.

The antenna array has been tested, and results indicate that the beam may be pointed throughout a hemisphere by varying the input phase to the individual elements. The results agree closely with theoretical calculations. The support of the National Aeronautics and Space Administration under contract NAS8-11251 is gratefully acknowledged.

Plasma Studies In A Shock Tube Utilizing A Microwave Probe

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The measurement of electron density and collision frequency in ionized gas flows by a transverse microwave probe was described.

Observed transmission and reflection coefficients and their phases were interpreted using an idealized plane wave-plane slab model. Effects of various departures from the ideal situation were described and evaluated. Application of the technique to study ionization kinetics behind shock waves in a shock tube was outlined. Some results were discussed for electron densities in the temperature range 7,000 to 10,000° K in argon.

A Dynamic Programming—Probablistic Approach To Variable Demand Production—Inventory Control

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A major problem of many industries is inventory control and production scheduling when variable product demand exists. The problem arises because of the need to satisfy non-deterministic product demand while simultaneously maintaining an appropriate product inventory and controlling production to replenish depleted inventory. This paper presents a method that can be used to attack this problem.

The method combines the mathematical optimization technique of dynamic programming with appropriate probability and cost matrices to yield a sequential schedule of production levels over an arbitrary length planning interval such that expected costs are minimized when variable demand exists.

Production levels, inventory levels, product demand levels and associated demand level probabilities, and costs of production, inventory and unsatisfied demand are specified for any problem. A production – inventory planning interval is chosen which consists of a set of smaller equal-size production control intervals. At the beginning of any production control interval any one of a set of finite "net demand conditions" can exist. For each possible net demand condition at the beginning of each production control interval, one and only one production level is chosen such that the expected cost of 1) production, 2) inventory, and 3) unsatisfied demand is minimized for the remainder of the planning interval in spite of any sequence of variable product demand that may occur. Thus, a complete production control schedule is developed for the chosen planning interval, while associated expected costs are minimized.

A primary advantage of the method is that it generates a completely flexibile and optimal production control schedule over the entire chosen planning interval, an optimal production control level being specified for each possible net demand condition at each production control interval. Hence, adverse effects of variable demand on inventory levels and production control strategies are virtually eliminated.

This paper states precisely the nature of the basic problem, a brief statement of the solution method, assumptions and restrictions required of the problem formulation, and a statement of problem formulation details.

Lunar Terrain Analysis

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The purpose of the Lunar Terrain Analysis was to analyze the distribution of lunar topographic and geologic features of scientific interest in order to assess surface mobility requirements for early lunar exploration missions.

The study provided an analysis of lunar geology and geologic age classification. It classified, reviewed, and analyzed Aeronautical Chart and Information Center Charts and United States Geological Survey maps. A presentation of singular lunar sites of special interest was made, and a study of the Apollo Landing Belt was effected.

The work is described in detail in Technical Report H-MOL-20, prepared by Hayes International Corporation, Apollo Logistic Support Group, in response to Contract NAS 8-5307 for the George C. Marshall Space Flight Center, NASA, Huntsville, Alabama.

Configuration Effects On The Stability And Maneuverability Of A Missile

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A method has been developed which facilitates determination of the flight characteristics of many missile configurations. Transfer functions are derived which relate various flight parameters such an angle of attack, acceleration rate, and pitch angle to the missile control system. These transfer functions can be analyzed by classical servomechanism techniques developed for the most part by electrical engineers. Application of several of these techniques to

the transfer functions leads to a complete analysis of the dynamic response characteristics of the complete missile.

The stability derivatives required for a numerical analysis of the airframe transfer functions are evaluated using the basic geometrical parameters of the missile. This evaluation has been accomplished by utilizing an IBM 7040 computer and results have proven to be within a tolerable degree of accuracy. Interference effects between wing and body, tail and body, and wing and tail have been included so as to minimize inaccuracies in the stability derivative evaluations.

The method has been used for the analysis of several missiles and results have been in excellent agreement with available experimental data. Further development of the method for application to more missile types will undoubtedly dictate modifications which should be made in the procedure. However, the development thus far has proven quite useful, and the method should be readily adaptable to many such preliminary analyses.

Annual Business Meeting

BIRMINGHAM-SOUTHERN COLLEGE

April 2, 1966

The meeting was called to order by President Sulzby at 10:00 A.M.

The President announced that minutes of the 1965 Annual Business Meeting had been mailed to the membership.

277. Motion by Wheeler, seconded by Carmichael that the minutes of the 1965 Business Meeting be approved as mimeographed and mailed to the membership. Motion carried unanimously.

REPORT OF THE PRESIDENT (SULZBY). The Academy progressed during the year in a satisfactory manner. This is attributed to meetings with officers from time to time when duties and responsibilities were discussed. To each the Past President and President-Elect were invited. Evidence of a growing Academy is displayed by the fine program and attendance exhibited at this meeting.

REPORT OF THE SECRETARY (DEVALL). The success of this the 43rd Annual Meeting of the Academy can be attributed to the leadership of a very energetic President and a dedicated and meticulous committee on local arrangements.

Attendance has been greater than expected. By comparison the 271 persons who have registered for this meeting compares with the 250 in 1965 at Florence; 235 in 1964 at Auburn; 166 in 1963 at Tuscaloosa; 138 in 1962 at Troy; and 135 in 1961 at Mobile.

An active membership campaign by several sections has been reflected in the attendance at this meeting. Registration by sections according to the registration cards has been as follows:

I	Biological Sciences	57
II	Chemistry	26
III	Geology and Anthropology	27
IV	Forestry, Geography & Conservation	9
V	Physics and Mathematics	28
VI	Industry and Economics	14
VII	Science Education	45
VIII	Social Sciences	10
IX	Medical Sciences	20
X	Engineering	16
	Miscellaneous	19
	Total	271

It is significant to note that 40 agencies, organizations, and institutions are represented in this registration.

278. Motion by Eisele, seconded by Twellmeyer that the report of the Secretary be accepted. Motion passed unanimously.

The Treasurer made no formal report. It was pointed out that the financial status of the Academy is good and that the status of funds is as follows:

Balance in Checking Account, December 31, 1965	$2,663.18
Balance in Savings Account, December 31, 1965	$1,274.20

REPORT OF THE NATIONAL SCIENCE FOUNDATION VISITING SCIENTISTS PROGRAM (WHEELER). Academy members are encouraged to participate in the Visiting Scientists Program. There is an opportunity to work with teachers in the various schools and to deliver formal talks before science clubs and classes.

ADMISSION TO MEMBERSHIP COMMITTEE (DeVall). The Academy began the year 1965 with 656 members. At the end of the year a net gain of 84 increased membership to 740. The increase of 152 new members was offset by a loss of 68 through resignation, nonpayment of dues, and death.

It is significant to note that 150 or 82% of the 182 persons nominated for membership accepted and their names are now on the rolls of the Academy.

The net loss of 68 members is high. All but 9 were dropped for nonpayment of dues. It is apparent that 150-175 new members can be added each year if all ten sections actively pursue a membership campaign.

PLACE OF MEETING COMMITTEE (Thomas). The 1967 Annual Meeting will be held at the University of Alabama Huntsville Center, Huntsville, Alabama. The dates approved for the meeting by action of the Executive Committee are April 7-8. The Executive Committee has also approved the location for the 1968 Annual Meeting. It will be held at Mobile College, Mobile, Alabama. Dr. A. Garrett Hill will serve as Chairman of Local Arrangements for the 1968 meeting.

SPECIAL COMMITTEE ON BY-LAWS (Baswell). A number of minor changes in the By-Laws were suggested by the committee and approved by the Executive Committee on March 31. The category 'Junior Member' was deleted since the Academy has never had a member in this class. The period covered by dues paid by new members joining after October 1 was clarified. A cutoff date was approved for members delinquent in dues. The membership procedure was revised so that it would be in agreement with the present procedure of nominating new members and inviting them to join. The Anthropology group previously associated with Geology was moved to Social Sciences thus creating a section of Geology and a section of Social Sciences and Anthropology. Duties of Vice-Presidents and Vice-Chairmen were clarified and a new section outlining the duties of the Vice-Chairman was approved. The procedure for handling abstracts of papers was changed to reflect the current procedure being followed.

279. Motion by Baswell, seconded by Twellmeyer that the Academy ratify the amendments to the By-Laws as approved by the Executive Committee in regular session on March 31. Motion passed unanimously.

AUDITING COMMITTEES FOR ACADEMY AND THE JUNIOR ACADEMY (Baswell and Summersell). The records of the Senior Academy and Junior Academy were inspected. It was apparent that all income and expenditures have been accounted for.

RESOLUTIONS COMMITTEE (Wilks). Your Resolutions Committee submits the following resolution:

WHEREAS, during the past year death has deprived the Academy of the valued services of three members; now, therefore, be it resolved that the Academy express its sympathy to the families of JAMES R. GOETZ, A. R. LONG, and E. F. RICHARDS; and express its appreciation for the loyal and valuable services these members have given to the Acadecy.

280. Motion by Wilks, seconded by Baswell that the Resolutions presented by the committee be adopted. Motion passed unanimously.

NOMINATING COMMITTEE (BARRETT). The Nominating Committee submits the following nominees for Academy Offices for the terms beginning April 2, 1966:

President-Elect: Dr. H. Ellsworth Steele
Treasurer: Dr. John M. McKibbin
Editor of Journal: Dr. Robert T. Gudauskas
Associate Counselor of the Junior Academy: Dr. Joseph C. Thomas
Trustees: Dr. J. F. Volker, Dr. Walter B. Jones
Vice-Presidents:
Section III. W. Gary Hooks
Section VII. Hollis C. Fenn
Vice-Chairmen:
Section I. Dr. William Miller
Section II. Dr. Raymond Isbell
Section III. Otis M. Clarke, Jr.
Section IV. William C. Aiken
Section V. Dr. Romas A. Shatas
Section VI. Charles Thomas Moore
Section VII. Mrs. Ann U. Everett
Section VIII. Thomas A. Belser, Jr.
Section IX. Dr. Geraldine M. Emerson
Section X. To be appointed.

281. Motion by Baswell, seconded by Yancey that nominations be closed and that each nominee for office be declared elected. Motion passed unanimously.

The President called for items of Old Business. There being none the President called for Items of New Business.

282. Motion by Twellmeyer, seconded by Baswell that the Articles of Incorporation be amended by deleting from Article VIII, Sec. 1, the phrase, "Coordinator of Science Clubs of America." (By previous action of the Executive Committee the position of Coordinator of Science Clubs of America was deleted from the By-Laws. It was therefore, thought advisable that this change also be made in the Articles of Incorporation.) Motion passed unanimously.

There being no further new business or announcements, the 1966 Annual Business Meeting of the Academy was adjourned at 10:25 A.M.

W. B. DEVALL, Secretary

THE JOURNAL

OF THE

ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

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Auburn, Alabama

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An Evaluation Of A Subjective Technique Used In Making Inventories Of Forest Vegetation[1]

STANLEY R. GEMBORYS
Department of Botany and Plant Pathology
Auburn University, Auburn, Alabama

INTRODUCTION

The study reported here is a part of a larger work that involves determination of the site indices[2] of *Pinus taeda* L. stands found on Piedmont soils of east-central Alabama. These determinations of site indices are to be based solely upon the relative abundance and per cent cover of certain understory indicator species (Smith, 1961), which are listed in Table 1. This method, to be of practical utility, requires a rapid, yet accurate technique for determining the presence and relative abundance of the indicator species within individual loblolly pine stands.

The subjective evaluation procedure used was a modification of the combined cover-abundance scale proposed by Braun-Blanquet (1932). Although the original wording of the scale has been altered, the meanings of the several classes as originally proposed by Braun-Blanquet have been essentially retained (Table 2). The revised scale is used to rank plant species on a numerical basis, with values ranging from 0 to 7. The lower scale values deal primarily with abundance and the upper with per cent cover.

The scale is rapid and easy to use in the field. However, little work has been done to evaluate rapid and subjective methods such as this one, against more conventional and objective quadrat techniques. Poore (1955) believes that results obtained through the Braun-Blanquet procedure will be unsuitable for anything more exacting than qualitative comparisons.

Hope-Simpson (1940), working with grassland communities, tested the consistency of a verbally defined frequency scale (dominant, codominant, very abundant, abundant, frequent, occasional, rare, and local) by comparing the results he obtained with those obtained by another worker on the same plots 18 years earlier and

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[1] Report resulting from a special problem directed by Professor Earl J. Hodgkins and undertaken as part of a larger study of the Department of Forestry, Auburn University, entitled "Determination of Site in Pine Forests by Means of Indicator Vegetation."

[2] Site index: the expected height of the average dominant tree in a given stand at age 50 years.

TABLE 1. Understory indicator species of Smith (1961) (Nomenclature after Kelsey and Dayton, 1942 except where otherwise noted)

Scientific Name	Common Name
Ilex decidua Walt.	Possumhaw
Diospyros virginiana L.	Common persimmon
Quercus falcata L.	Southern red oak
Ceanothus americana L.	Jerseytea ceanothus
Rhus glabra L.	Smooth sumac
Vaccinium Elliottii Chapm.[1]	Elliott's blueberry
Sassafras albidum (Nutt.) Nees	White sassafras
Liquidambar styraciflua L.	American sweetgum
Lonicera japonica Thunb.	Japanese honeysuckle
Toxicodendron radicans (L.) Kuntze	Common poison ivy
Cornus florida L.	Flowering dogwood
Crataegus uniflora Muenchh.	Oneflower hawthorn
Liriodendron tulipifera L.	Yellow poplar
Vitis rotundifolia Michx.	Muscadine grape
Acer rubrum L.	Red maple
Cornus alternifolia L.	Pagoda dogwood
Carya spp. Nutt.	Hickory
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper
Oxydendrum arboreum (L.) DC.	Sourwood
Myrica cerifera L.	Southern waxmyrtle
Quercus rubra L.[2]	Northern red oak

[1] Not listed in Kelsey and Dayton (1942). Nomenclature after Fernald (1950).
[2] Nomenclature after Fernald (1950).

TABLE 2. Modified Braun-Blanquet cover degree-abundance scale

Scale value	Description
0	Absent.
1	Must hunt. Of erratic occurrence and apparently only one, two, or three in the plot area, or only one small patch.
2	Can see from one place by looking intently, and can see readily by moving around. If in patches, must move around to find the patches. Less than 5 per cent cover.
3	Abundant, easily seen from one place but less than 5 per cent cover.
4	Abundant. 5-25 per cent cover.
5	25-50 per cent cover.
6	50-75 per cent cover.
7	75-100 per cent cover.

also with his own very careful estimates made from 2 to 3 days after the first ones. He concluded that, while the system had merit, its utility was based on the degree of precision required, i.e. it was adequate for low precision work, but not for work requiring high accuracy. He felt that a large number of the inaccuracies encountered were because of different interpretations of the descriptive terms made by different workers.

Subjective ocular methods have been used and found acceptable in the fields of forestry (Chapman and Meyer, 1949) and range management (Stoddart and Smith, 1955). The high precision attained by these subjective evaluations is the result of making frequent comparisons of these evaluations with objectively determined data.

In this study estimates made by two workers using the same modified Braun-Blanquet scale on the same areas and in rather close temporal sequence were compared. The study also compares these estimates with standard quadrat determinations of frequency and per cent cover.

PROCEDURE

Sixteen plots were established in Chambers County, Alabama, and in the Piedmont Plateau portion of Lee County, Alabama, in the fall of 1963 by Joseph P. Wallace.[3] The procedures used in establishing these plots followed those outlined by Smith (1961). Each plot was at least one-half acre in area and uniform with respect to site quality, as determined by observations of soil characteristics, topography, and vegetation. No plots were established on lower slopes. The areas had been out of cultivation for at least 30 years, so that rapid early stages of plant succession should have been accomplished. Each plot was located in a stand containing sufficient loblolly pine in the dominant and co-dominant tree classes for accurate determination of site index.

In the spring of 1964, B. C. Smoot[4] (hereafter designated Worker A) visually classified the 21 indicator species on each of these plots using the modified Braun-Blanquet cover degree-abundance scale. During late spring and early fall of 1965, the writer (hereafter designated Worker B) re-inventoried the same species on 12 of the original 16 plots (3 of the 16 could not be located and a fourth had been severely disturbed as the result of a logging operation). On each of the 12 plots, the 21 indicator species were (1) rated in accordance with the modified Braun-Blanquet cover degree-abundance scale and (2) evaluated for frequency and cover using milacre quadrats. In the latter procedure, 30 quadrats, each 6.6 × 6.6 ft, were systematically distributed throughout the plot.

Data obtained by the two methods were taken separately to minimize any bias that might be introduced into the subjective estimate. At each plot the subjective data were recorded and the quadrat data were then taken. This prevented undue familiarization with each plot prior to the subjective inventory. Thus, the conditions under which Workers A and B made the subjective evaluations were as similar as possible. No changes were made in the subjective tallies, even when subsequent quadrat inventories revealed species that had not been listed in the subjective evaluations.

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[3] Joseph P. Wallace was a senior in the Auburn University Department of Forestry and was a part-time student laborer.

[4] B. C. Smoot was a graduate student in the Auburn University Department of Forestry and was a part-time student laborer. Both Wallace and Smoot were trained by Professor Earl J. Hodgkins but were working under remote supervision.

RESULTS

The total number of assignments in each Braun-Blanquet category is given for each investigator in Table 3. Corresponding frequency and cover means and ranges derived from the quadrat data obtained by Worker B are given for the Braun-Blanquet scale value assignments made by each worker. The quadrat frequency and cover means are plotted graphically over corresponding Braun-Blanquet assignments in Figure 1.

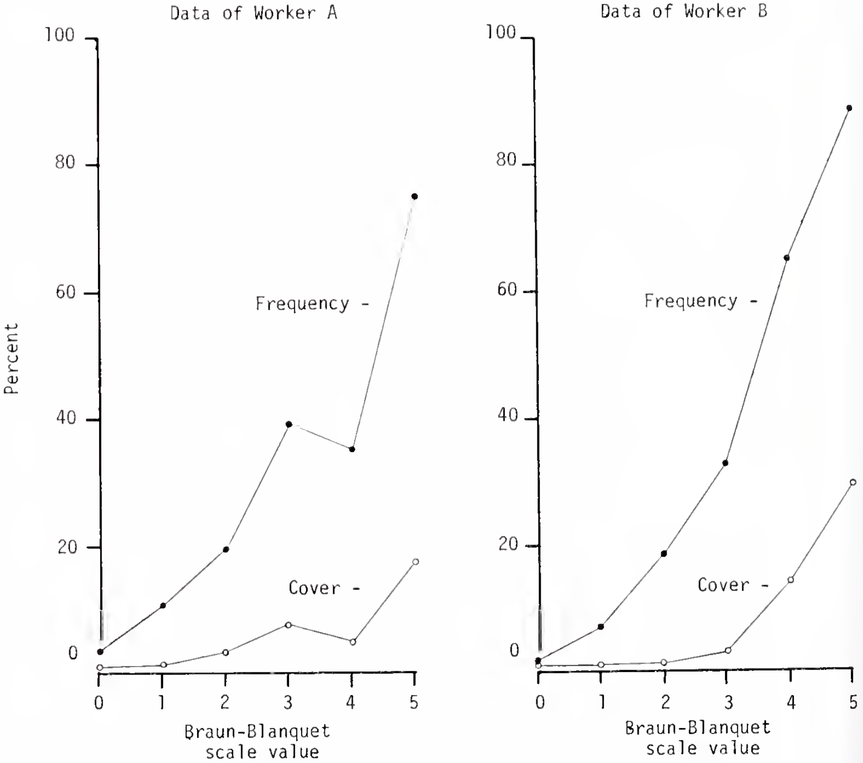

FIGURE 1. Average percentages of frequency and cover[1] corresponding to Braun-Blanquet scale values assigned by each worker.

[1] Frequency and cover percentage means are calculated from the quadrat inventories.

The subjective abundance cover estimates of Worker B were on the average in reasonable progressive relationship with the quadrat data. Worker A, on the other hand, apparently made no real distinction between classes 3 and 4 on the Braun-Blanquet scale, and made Class 5 assignments that perhaps should have been Class 4. He also tended to generally underestimate cover when it exceeded 5 per cent.

A direct comparison was made between the subjective Braun-Blanquet estimates arrived at by the two different workers. Arbitrary agreement classes were assigned with "A" being designated as a perfect agreement, "B" different by one scale value, "C" different by two scale values, and "D" different by three scale values.

TABLE 3. Total number of assignments by each worker for each Braun-Blanquet scale value with corresponding frequency and cover means and ranges from the quadrat inventories of Workers B

Braun-Blanquet scale value	No. of assignments	Quadrat data			
		Frequency		Cover	
		Mean	Range	Mean	Range
		Per cent	Per cent	Per cent	Per cent
		Data of Worker A			
0	125	3.5	0.0-36.7	0.33	0.00-10.00
1	77	10.5	0.0-43.3	0.96	0.00- 3.86
2	25	19.5	0.0-46.7	2.89	0.00-11.13
3	18	39.1	13.3-75.6	7.82	1.41-17.33
4	5	34.7	3.3-60.0	4.76	0.03- 9.63
5	2	75.0	63.3-86.7	17.63	2.46-32.80
		Data of Worker B			
0	129	0.7	0.0-16.7	0.07	0.00- 4.00
1	58	7.2	0.0-20.0	0.66	0.00- 1.69
2	27	18.6	0.0-28.7	1.19	0.00- 2.26
3	24	32.5	6.7-63.3	3.34	0.67- 6.69
4	12	65.0	35.0-83.4	13.92	6.00-24.70
5	2	88.4	86.7-90.0	29.80	26.80-32.80

TABLE 4. Per cent agreement between two workers in assigning Braun-Blanquet scale values on the same plots

Agreement class[1]	Number Found	Percentage Agreement	
		0-0 Included	0-0 Not Included
Class A	120	47.6	
Both values 0	(81)		
Both values not 0	(39)		22.8
Class B	95	37.7	55.6
Class C	26	10.3	15.2
Class D	11	4.4	6.4
Total	252	100.0	100.0

[1] Class A—exact agreement.
Class B—different by one scale value.
Class C—different by two scale values.
Class D—different by three scale values.

Since the number of 0-0 class A agreements may be unduly weighted by the inclusion of absent species, it was decided to list agreement percentages in two ways, with and without the 0-0 class A agreements. The results of these comparisons are given in Table 4. If we include the 0-0 agreements in class A, the agreement percentages seem acceptable for studies where a moderate degree of precision is desired. However, when the 0-0 class A agreements are disregarded, agreement between workers is poor.

The utility of the subjective technique in determining species presence was analyzed since this parameter by itself is often used to describe plant communities. In Table 5 are given the total number of species presence assignments by each observer and for the quadrat surveys which show the extent of coincidence in these assignments. The highest incidence of agreement is that found between Worker B's Braun-Blanquet inventory and the quadrat survey. The lowest coincidence is for both Braun-Blanquet inventories and the quadrat inventory taken together as would be ex-

TABLE 5. Number of species presence assignments for various combinations of workers and techniques

Combination	Number of assignments
Individual Assignments	
Worker A's Braun-Blanquet	127
Worker B's Braun-Blanquet	123
Worker B's quadrat method	126
Coincident Assignments	
Worker A's Braun-Blanquet with Worker B's Braun-Blanquet	82
Worker A's Braun-Blanquet with Worker B's quadrat method	88
Worker B's Braun-Blanquet with Worker B's quadrat method	112
Worker A's and Worker B's Braun-Blanquet with Worker B's quadrat method	78

TABLE 6. Number of individual Braun-Blanquet scale values assigned by each worker and calculated average scale value per worker

Braun-Blanquet scale value	Number assigned by Worker A	Number assigned by Worker B
0	125	129
1	77	58
2	25	27
3	18	24
4	5	12
5	2	2
Total	252	252

Average scale values: Worker A 0.84; Worker B 0.96

pected. The next to lowest amount of coincidence is between the two Braun-Blanquet inventories by different workers.

The average Braun-Blanquet scale value assigned by each worker was determined (Table 6). In the cases studied, Worker A tended to assign lower values than did Worker B. Whatever the reason, this is a large factor in causing the high disagreement percentages noted previously (Table 4).

DISCUSSION AND CONCLUSIONS

Results of this study indicate that the agreement between a single worker's subjective Braun-Blanquet estimate and more objective quadrat data can be quite high, even when the objective inventory is made *after* the subjective inventory on any one plot. It is possible that Worker B, as a result of making frequent quadrat per cent cover estimates, became more proficient in assigning those Braun-Blanquet scale values which deal primarily with per cent cover. If this should be the case, it is a factor that should be considered when training workers to use the Braun-Blanquet scale. Frequent checks made on subjective estimates with quantitative methods would extend the usefulness of this technique.

It is evident that the agreement between different workers using the same subjective method and between different workers using different techniques, i.e. subjective Braun-Blanquet versus quadrat types, can be very poor. Poor agreement of Worker A's data with Worker B's Braun-Blanquet and objective inventories is probably the result of several factors: (1) Worker A was trained in wood technology, whereas Worker B's major training is in plant ecology; (2) Worker A was working for financial reward only and Worker B was attempting to solve a basic problem in his own chosen field; (3) Worker A did not check his subjective Braun-Blanquet estimates against objective methods, whereas Worker B, while never running specific checks on any of his assigned Braun-Blanquet Scale values, perhaps did in effect "school" himself toward more efficient subjective estimating through frequent employment of quadrat estimating; (4) Worker A's data were obtained a year prior to the quadrat data, whereas Worker B's Braun-Blanquet data were obtained immediately prior to the quadrat data.

In conclusion, a subjective Braun-Blanquet type inventory technique used by a single worker can show a high degree of accuracy if frequently checked against relatively objective estimates. Unchecked subjective inventories of this kind should be suitable for rough appraisals, as in reconnaissance work, especially if the worker is experienced and competent.

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French Military Surgery During The Campaigns Of 1792-1793

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When revolutionary France declared war on Austria and Prussia on April 20, 1792, the ensuing hostilities revealed many areas in which military medicine was inadequate to meet human needs. Two especially dread enemies reappeared: gangrene and tetanus. Their causes were unknown and their proper treatment baffled French medical men. Gangrene was commonly treated by minor surgery and poultices, while a wide variety of medicants were in vogue for treating those suffering from tetanus. As the lives of thousands of soldiers were being claimed by these two killers, French military surgeons such as Dominique Jean Larry (1814) and François Briot (1817) began practicing immediate amputation as the sole means of saving their patients.

In the eighteenth century, tetanus was almost always fatal and its cause was a mystery that encouraged various theories. The popular explanation was that tetanus was brought on by violent passions which seized a person, such as fear or anger. The provincial surgeon Paul Canin noted in 1792 a patient responding well to opium treatments but who suddenly worsened and died when someone stole his purse. Claude Leclerc, a reputable military surgeon, insisted that he saw on the battlefield many greatly frightened men die of tetanus. Another surgeon explained that anger introduced tetanus into the muscular system, while many medical men confused tetanus with apoplexy and epilepsy.

As most surgeons had observed, *clostridium tetani* (sometimes called the *tetanus bacillus*) did affect the central nervous system. It lived and bred in filth and was especially prevalent near stables and in animal manure. It usually entered the body through wounds, ranging from nails and splinters to gunshot and surgical lacerations. In 1793, the great French surgeon Pierre Percy noted that the greatest incidence of tetanus was in hospitals near horse-drawn cannon batteries but drew no conclusions from this fact. At the same time, François Briot became the first to distinguish between what he called "chronic tetanus" — a form that would respond to treatment — and "acute tetanus" which was fatal in a few days, but this discovery offered no clue to the cause of either form.

In the 1790's, the treatments for tetanus were as widely varied as were the explanations. The old medical authorities had taught the use of opium and mercury. Some innovaters in medicine tried newer eighteenth century discoveries, such as electricity and castor oil. In 1793, military surgeons Claude Lombard and Antoine Lorentz were using purgatives to treat tetanus, while Jean Larrey (1803) prescribed opium mixed with camphor. Nicolas Huerteloup in 1794 was using musk and cold baths. The standard treatment for tetanus in the Army of the Rhine during 1792-1794 was a mixture of two measures of potash in nine to twelve ounces of water and twelve grains of opium during a twenty-four hour period. As palliatives, some of these prescriptions may have eased the pain of those dying from tetanus but the nature of the disease remained a mystery.

In types of gangrene, the eighteenth century medical world made no distinction. The type most frequently seen was called "gas gangrene" or "wet gangrene," especially in warfare. In ordinary medical practice, gangrene was usually pursued by the surgeon's scalpel. Small incisions and then larger incisions to secure free drainage, a careful cutting away of infected tissue, and cleaning the wound with water were standard measures aimed at controlling the spread of gangrene. It was known that gangrene was common in wounds of the thigh, the leg, and the forearm. Larrey and Briot observed that its worst ravages occurred in hot and humid weather and individuals who "abounded in fatty cell tissue." Larrey soon rejected the prevalent notion that gangrene could be absorbed by the body and taught that prompt amputation was the sole means of saving the patient.

After an unhappy experience at Plaisance, France in December 1792, Briot (1817) came to the same conclusion. His patient was a soldier who had walked four kilometers to the hospital with a sabre cut on the outside of his right knee. Briot applied a pressure bandage to the now badly-separated wound, applied poultices, exercised the knee, and bled the patient. He pursued the gangrene with the scalpel into the knee joint but, while allowing free drainage, this limited surgery did not stop the formation of enormous abscesses. Nothing Briot did relieved the terrible pain nor stopped the spread of gangrene and the soldier soon died. Belatedly, Briot wrote, it occurred to him that he might have saved his patient by an early amputation.

French surgical principles, established well before 1792, inadvertently encouraged such fatalities, however. In cases involving tetanus, amputation had never been recommended because it was believed to be ineffective. For controlling gangrene, Henri Le

Dran's medical text (1737) had taught quick amputation but later opponents of amputation had driven Le Dran's ideas out of the medical schools. Johann Ulrich Bilguer was the most influential surgeon of the generation before 1789 who fought against amputation. His monograph on the subject, *Dissertation sur l'inutilité de amputation des membres* (1764), had been translated into a number of languages. His principles were championed by the French Royal Academy of Surgery and by the great surgeon at the *Charité* hospital in Paris, Pierre Desault, who favored amputation only as a last resort. Six conditions in which amputation was permissable had been laid down by Bilguer: bad mangling of a limb with death threatening; uncontrollable gangrene; massive contusion and multiple fracture; severe injury to the great arteries; incurable bone decay; and cancer. These rules were based upon his compilations of results of peacetime amputations and on the popular "vital forces" theory of medicine, which held that a wounded man's reaction to amputation would be critical because of the feeble state of his vital forces.

Briot thought that these ideas may have been suitable for peacetime surgery but observed that war presented surgeons with entirely different circumstances. They saw limbs partially shot away by artillery, bones splintered by balls, members left hanging by only a few threads of flesh, joints torn and shattered, terrible burns, and massive hemorrhages. For a physician during a retreat or in an exposed position surrounded by a host of such terrifying wounds, there was no time to follow a rigid doctrine. As Briot said, "The mind did not have time to reason, to calculate probabilities, or to create resources. Experience and coldbloodedness counted for more than talent. Everything had to be done with prompt and decisive action."

A calm and unhurried melieu, necessary for the task of laboriously picking out bone splinters and bits of clothing from gaping wounds, was not given to military surgeons. In the smoke of battle or by flickering candlelight, locating the open ends of severed arteries and tying them off was an enormous problem. There was also the frustration of trying to set and adequately splint a very complicated fracture under battle conditions. Although some wounds did not in themselves dictate amputation, it often had to be done because the patient could not otherwise survive the rigors of transport to the rear.

Nevertheless, Pierre Percy's surgical manual, published in 1792, laid down the accepted conservative rules about amputation as a last resort and, in his capacity as surgeon-in-chief of the Army of the North and of the Moselle, he fought diligently to enforce these rules. He complained of having too many "pseudo-surgeons who counted their battle actions only by the number of arms and legs they had cut off." Indeed, there were numerous surgeons who fitted the description of the celebrated Jacques Lisfranc (1790-1847): "so obsessive a scalpel-wielder that he lamented the passing of the Napoleonic age when the grenadiers had provided him with so many splendid opportunities for amputations."

Conservative practitioners such as Pierre Percy, Claude Lombard, Raphael Sabatier, and Pierre Desault favored bone resection, involving the removal of all splinters and all foreign particles from a fracture and joining the remaining bone extremities. This was a serious operation that required long treatment and usually resulted in pseudo-arthrosis, functional weakness, or death, but it often saved the limb. Bone resections were mostly clinical rarities. The first surgeon to successfully rejoin an arm to the shoulder was Charles White in 1768. The opponents of amputation, however, with so many unprecedented opportunities for experimentation, now championed bone resection. Ambutation was authorized only if resection failed. As a result, in 1792-1793, quite a few successful resections were made. Larrey was the first French surgeon to rejoin an arm to the shoulder during the campaign of 1792, although Percy performed this operation successfully many times during the period 1792-1795. The first resection of the knee was done by P. F. Moreau (of Bar-sur-Ornans) in 1792 and Percy is credited with assisting him. Larrey, in 1793, was the first French surgeon to resect an elbow joint. Most surgeons came to prefer resections to amputations in the joints because the tissues at the knee and elbow were not suitable for an adequate flap.

Larrey practiced bone resection but, as surgeon-in-chief of the Army of the Rhine, he did not champion it. He did his best, in fact, to resist the dogmatic rules on amputation. In this, he was bitterly opposed by Percy. Larrey was less concerned with saving limbs than he was with saving men from gangrene and tetanus. He recalled what he had heard surgeons of the War of American Independence say about the advisability of early amputation. He had personally seen the tragic and fatal results of Desault's avoidance of amputation at the time of the 1789 Réveillon riots. Early in 1792 during the bombardment of Kell, Larrey saw three volunteers who had limbs shattered by exploding shells. They were attended by Simon Boy, who was then a surgeon first-class at the Strasbourg military hospital. Larrey observed that Boy waited "several days before amputating; not a one [of the wounded men] had the good fortune to recover."

Of the campaigns of 1792-1793, Larrey said, "I had carefully observed the phenomena attending gunshot wounds and perceived the advantage of immediate amputation, when the injury required it." At Perpignan, late in 1793, Larrey tried to save two soldiers whose amputations had been delayed by seven or eight days, but one died of tetanus and the other of gangrene. Having satisfied himself of the errors of men like Desault and Percy, Larrey argued for on-the-spot amputation. To him, speed was vital, more vital than surgical technique. Larrey announced his "twenty-four hour" principle which required the amputation of shattered and infected limbs within that time limit to avoid the fatal consequences of tetanus and gangrene.

This principle won increasingly widespread acceptance among battle-field surgeons, despite the opposition of the conservatives. By 1795, the essentially civilian rules on amputation had been changed by the realities of wartime wounds and of battle surgery. Bone resection was too tedious and difficult for consistent battlefield performance and its results showed no appreciable tendency toward lessening the number of patients lost to gangrene and tetanus. New guidelines for amputation emerged from the controversy over quick amputation. Five conditions were in effect by 1795 for on-the-spot amputation: (1) shattered bones, (2) limbs partially or completely shot away, (3) much flesh and major arteries missing, even if the bone were sound, (4) muscles, nerves, and small bones too disordered, and (5) when joints were smashed and any hope of movement was gone.

There were few major wounds to arms and legs that did not meet at least one of these conditions for quick amputation. In every case, the immediate amputation lessened the possibility of fatalities from both gangrene and tetanus. Consequently, Larrey's "twenty-four hour" theory became the rule rather than the exception in French military surgery just before the Napoleonic wars began. The result was an established principle that enabled the surgeons of Napoleon's armies to save the lives of thousands of French soldiers who might otherwise have perished from the effects of tetanus or gangrene.

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Mineral Aggregates For Bituminous Paving Mixtures And Granular Base Courses

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INTRODUCTION

The science of mineral aggregates, a term which usually covers sand, gravel, crushed stone, and crushed slag, has been a sort of stepchild in the materials science. This is surprising because mineral aggregates are used in very large quantities. It has been estimated that the amount of mineral aggregates used in concrete alone was about three billion tons in 1963; that is, one ton for every living human being. In addition, considerable amounts of mineral aggregates were used in bituminous paving mixtures, in granular base courses for highways, in earth-work constructions, etc. Thus, there is only one material that is consumed in larger quantities than mineral aggregates and this is water.

Both the quality and the quantity of investigations concerning mineral aggregates have been lagging. For instance, there is no book or paper which presents an organized summary of the technically important properties of mineral aggregates and the results of the related, scattered research. Therefore, the Alabama State Highway Department in cooperation with the U.S. Bureau of Public Roads decided to sponsor a research project on this subject. As a result, the Department of Civil Engineering of Auburn University undertook an investigation concerning the fundamental role of mineral aggregates in highway engineering. A part of this work is presented in this paper.

AGGREGATE PROPERTIES IN GENERAL

Mielenz (24) has defined three terms which describe the physical properties of aggregate. These terms seem to be very descriptive and are reproduced below for reference.

"Satisfactory: Particles are hard to firm, relatively free from fractures, and not chiplike; capillary absorption is very small or absent; and the surface texture is relatively rough.

"Fair: Particles exhibit one or two of the following qualities: firm to friable; moderately fractured; capillary absorption small to moderately; flat or chiplike; surface relatively smooth and impermeable; very low compressibility; coefficient of thermal expansion approaching zero or being negative in one or more directions.

"Poor: Particles exhibit one or more of the following qualities: friable to pulverulent; slake when wetted or dried; highly fractured; capillary absorption moderate to high; marked volume change with wetting and drying; combine three or more qualities indicated under 'fair'."

Mielenz also listed nine properties of aggregates that affect their success or failure in highway construction.

1. Porosity, permeability and absorption.
2. Surface texture.
3. Volume change with wetting and drying.
4. Thermal properties.
5. Strength and elasticity.
6. Density.
7. Hardness.
8. Particle shape.
9. Coatings.

There are five categories of quality requirements for aggregate into which virtually all of the present state requirements can be placed (21). They are:

1. General
2. Abrasion Resistance
3. Soundness
4. Restrictions on Deleterious Constituents
5. Special Requirements

The purpose of the general requirements ". . . is to describe in general terms the type of material which is considered to be acceptable and second, to place in one category those rather nebulous requirements which undoubtedly influence the acceptability of the material, but for which a good quantitative method of test does not exist" (21).

In the literature it is generally concluded that the Los Angeles Rattler Test is superior to the Deval Test for measuring the abrasion resistance of aggregate. In 1935, Wolf and Runner (50) investigated the effectiveness of the two tests for measuring the abrasion resistance of aggregate. They concluded that the Los Angeles Test was superior to the Deval Test in nine different aspects (21). Sweet also writes that the service behavior of aggregate can be indicated by the Los Angeles Test, but not by the Deval Test (42). The Los Angeles Test has been adopted by most states and several foreign countries (25).

The Sulfate Soundness Tests are often specified to determine how aggregate will withstand the forces of weathering. Investigators have been generally pessimistic about this test and say that it provides a proper base for acceptance of an aggregate, but not for the rejection of the aggregate. Certain states are experimenting with a kerosene test to replace the Sulfate Test (45).

AGGREGATES FOR BITUMINOUS PAVEMENTS

Fine and Coarse Aggregates for Paving Mixtures

Bituminous paving materials consist of combinations of mineral aggregates with bituminous binders. Under this broad heading are included a multitude of pavement types, ranging from inexpensive surface treatments to asphaltic concretes which may compare in cost and quality with Portland cement concrete pavements.

Mineral aggregates constitute 88 to 96 percent of a pavement by weight, or something more than 75 percent by volume. The most commonly used mineral aggregates are broken stone and slag, crushed or uncrushed gravel, sand, and mineral filler (44). These materials may be used separately or in combination, depending on the type of bituminous pavement specified.

In spite of the many types of bituminous pavements, Pauls and Carpenter stated (29) that the ideal aggregate for bituminous

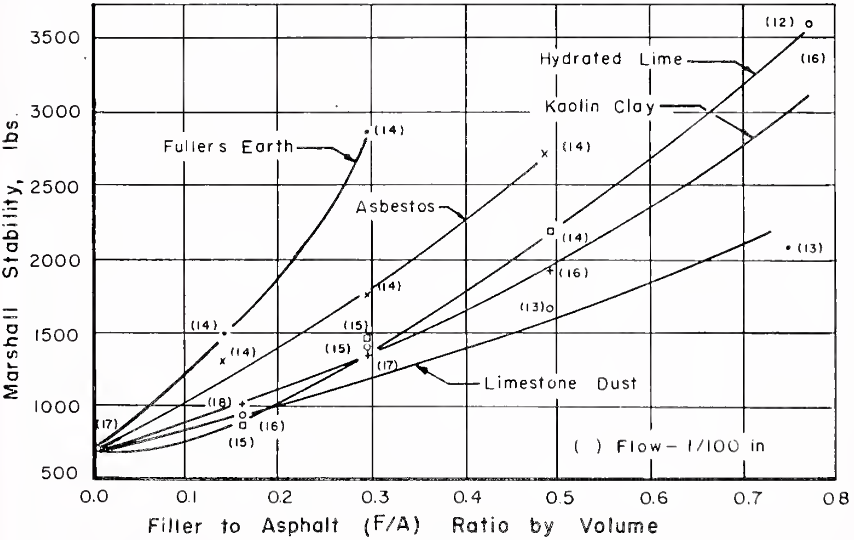

FIGURE 1. Effect of the filler on Marshall stability and flow of asphalt concrete (17).

construction, regardless of class or type, should have the following characteristics:

1. Adequate strength and toughness.
2. Ability to crush into chunky particles, free from flakes, slivers, and pieces that are unduly thin and elongated.
3. Low porosity (however it should not be completely lacking in porosity).
4. Hydrophobic characteristics.
5. Particle size and gradation appropriate to the type of construction.

The listed qualities are desirable in all aggregates, regardless of whether they are naturally occurring materials or are produced artifically by crushing and screening stone, slag, or gravel.

It must be emphasized that aggregates having all these desirable qualities may not be economically available in many areas. When this situation arises, locally available aggregates must be used. A

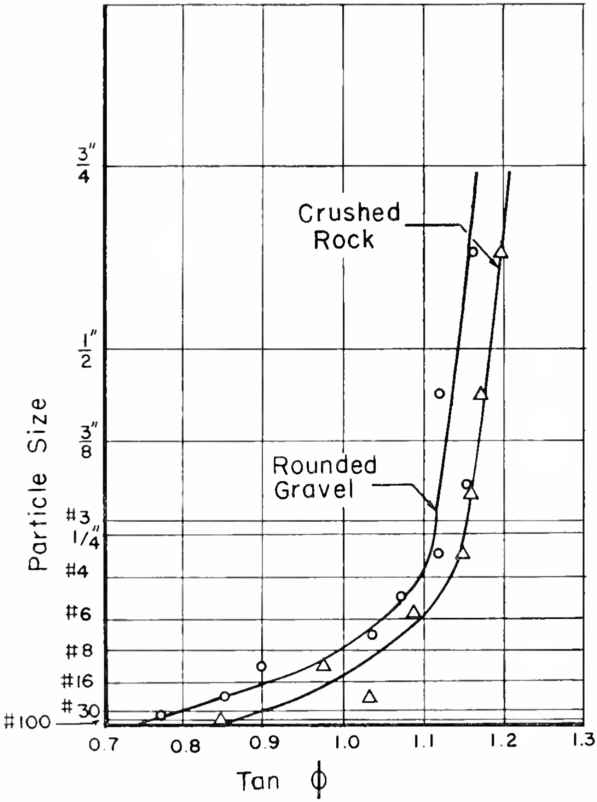

FIGURE 2. Variation of tangent phi with particle size (6).

wide variety of aggregate gradations (11) are used satisfactorily in bituminous pavements today. Generally speaking, extra costs entailed by the rigid enforcement of the qualities listed above may be justified for high type pavements carrying large volumes of traffic and involving high initial costs of construction, while less expensive aggregates may be used for other purposes (37).

The qualities of a material known as *hardness* and *toughness* have historically been regarded as essential to good aggregate. Prior to about 1936, the Deval Abrasion Test was used to measure the abrasion and toughness, but today practically all highway agencies specify the Los Angeles Rattler Test rather than the Deval Test. ASTM's and AASHO's abrasion requirements for three different types of bituminous pavements are listed in Table 1 (25).

Legend

Minor Component		Major Component		
		Sand	Silt	Clay
	Sandy	○	ϕ	-○-
	Silty	ϕ	|	+
	Clayey	⊖	+	—

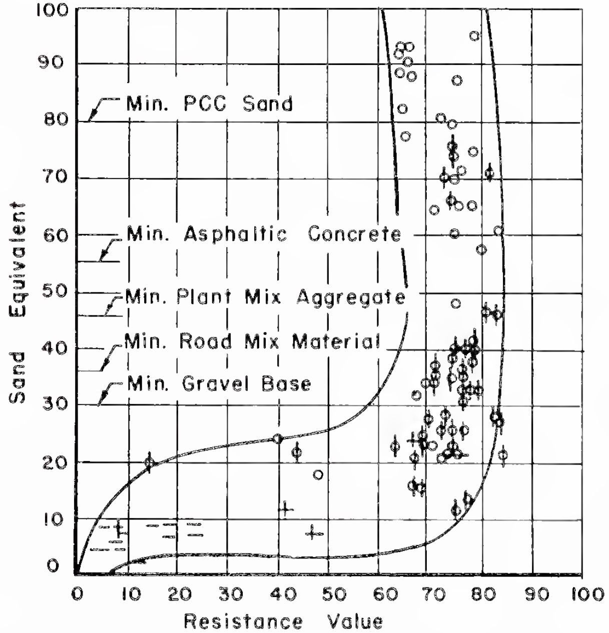

FIGURE 3. Sand-equivalent versus resistance value (16).

Good *crushing characteristics* are desired in order to prevent excessive breakdown or “degradation” of the aggregate in processes involving the use of heavy rollers. This degradation is most detrimental in bituminous macadams and surface treatments (37).

The *porosity* of aggregates used in highway construction is generally measured by their absorption. A slightly porous aggregate is desired for bituminous mixtures because a slight penetration of the bituminous material into the pores of the aggregate improves the adhesion of the bituminous material to the aggregate. A high degree of porosity is undesirable, however, because more bituminous material is required. The desirable amount of porosity is usually in the neighborhood of 1 percent (37).

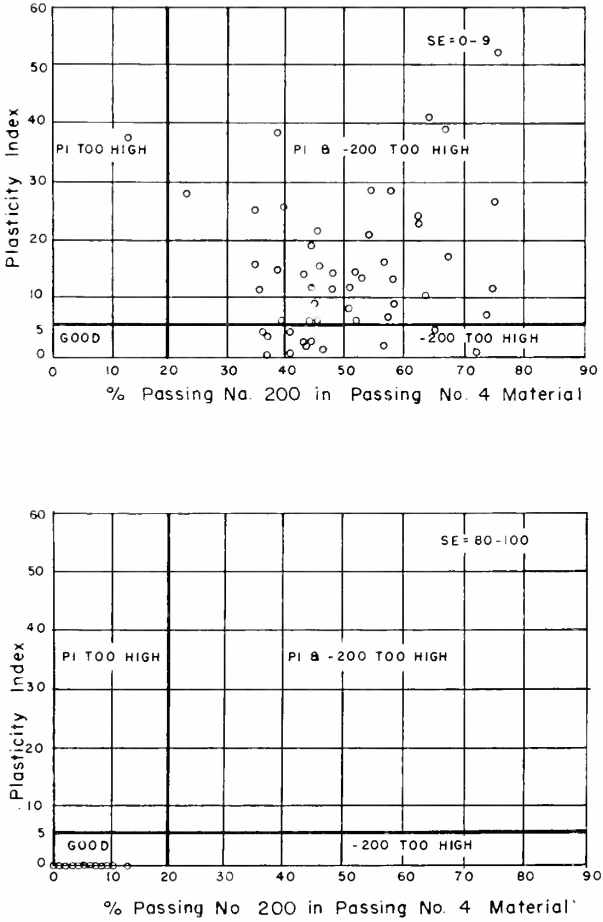

FIGURE 4. Relationship between sand-equivalent, plasticity index, and material passing sieve #200 (28).

If the binder separates or strips from the aggregate, the pavement will disintegrate under traffic (26). For this reason, aggregate used in bituminous pavements should be of a *hydrophobic* nature. This means that the aggregate has more attraction for the bituminous binder than for water. However, improved adhesion of bituminous films to hydrophilic (water-loving) aggregates has been obtained by the use of anti-stripping agents added to the bitumen (49). Several different procedures have been used in judging the relative resistance to film stripping of aggregate. One such test is AASHO designation T 182-57. Many states do not test for stripping because experience has shown that the available aggregates in those states are not susceptible.

.In many instances, some of the different types of aggregates previously listed are combined to give a *gradation* having certain characteristics that are desired or required for a particular type of pavement. In other instances, a single aggregate may have the desired gradation. The gradation of aggregate is important, as it determines, for the most part, the mechanical stability of the bituminous mix (3). However, gradation will not be discussed in detail here because almost all existing specifications use similar limit-curves for grading evaluation. Nevertheless, numerous papers that discuss the grading have been reviewed (2, 4, 5, 7, 12, 18, 30, 32, 41, 46, 47).

Soundness, although not mentioned in the preceding list, is one of the most important considerations in the selection of aggregates for highway construction. The most common soundness requirement for aggregates is based on the sodium sulfate or magnesium sulfate soundness test (ASTM designation C 88-55T). Unfortunately, the test method appears to need some improvement. Garrity and Kriege (9) recommended that it be used only for indicative purposes. This view was also expressed recently by Woolf (51), who added that the test be used for accepting materials but not for rejecting them. It should be noted at this point that, although soundness of the aggregate is important, it is probably not as important in bituminous pavements as in Portland cement concrete pavements. Generally accepted limits for aggregate loss in the sodium sulfate and magnesium sulfate tests are 12 percent and 18 percent respectively (34).

The preceding statement may apply to deleterious substances also. It is generally recognized that the presence of certain substances in aggregates for Portland cement is undesirable. Specifications for such aggregates normally contain a section in which the deleterious materials are named and a limit placed on the amount of each that is allowable. It is also recognized that the presence of small amounts of these substances is not as harmful to bituminous concrete as to Portland cement concrete. However, some agencies specify aggregates on the basis of class rather than on the basis of use and thus employ the same aggregate specifications of Portland cement concrete and some high type bituminous construction. In this case, specifications that are intended for control of aggregates used in concrete are imposed upon aggregates used in bituminous construction (21).

Several different tests are used for determining the amount of *clay-like* fines in an aggregate. The most suitable test seems to be the sand equivalent test.

Moisture in aggregate, even a very small percentage, has harmful effects on the quality of certain hot-mixed bituminous pavements. For this reason, aggregate should be almost completely dry when used in these bituminous pavements. Moisture contents below 0.05 percent will give satisfactory mixtures, while moisture contents above 0.1 percent will definitely cause unsatisfactory bituminous concrete mixtures. It may appear that moisture is one of the major problems in bituminous pavement construction. Actually it is not, as it has occurred only on a minority of projects. The moisture content of aggregates can be controlled by moisture tests coupled with careful analysis of the plant equipment and operations (31).

TABLE 1. Standard specifications for allowable loss, Los Angeles test

	ASTM			AASHO		
Material	Designation	Max. Percent Wear Los Angeles Abrasion Test		Designation	Max. Percent Wear Los Angeles Abrasion Test	
		Surface Course	Surface Treatment		Surface Course	Surface Treatment
Crushed stone and slag for bituminous macadam surface course	D 693-54	40	----	M 78-51	40	----
Crushed stone, crushed slag, and gravel for bituminous concrete surface course	D 692-54	40	----	M 79-51	40	----
Crushed stone, slag, and gravel for single or multi-bituminous surface treatments	D 1139-57T	----	40	----	----	----

Mineral Fillers

Mineral fillers for asphalt paving mixtures consist of fine mineral particles that are added to or are naturally present in the mineral aggregate, and that predominantly pass N.S. standard sieve No. 200 (17). AASHO's "Guide Specifications for Highway Construction" require that mineral filler consist of limestone dust, Portland cement, or other inert matter from sources approved by the engineer. As can be seen from the preceding specification, many different materials can be used as mineral fillers. The Central Road Research Institute of India conducted experiments to find out the potentiality of silty soil as a mineral filler for hot-mix bituminous concrete. They concluded that silty soils having a plastic index in the region of 14 can be successfully used as a filler in bituminous mixes (19).

Based on the results of studies, observations, and experience, two theories have emerged regarding the functions of fillers in bituminous mixes. One theory proposes that the filler serves to fill voids in the mineral aggregates; the other proposes that the filler and asphalt combine to form a mastic which acts to fill voids and also bind aggregate particles together. However, in mixes prepared in the conventional manner fillers serve predominantly to fill voids. Studies and tests have verified the fact that increasing quantities of filler tend to increase the stability and density of the mix. There is, however, a limit to the beneficial effects of increasing filler content. As filler content increases, the brittleness and tendency of the mix to dry out and crack in service also increases (7). Figure 1 compares the Marshall Stability to the filler to asphalt ratio for five different fillers (17).

Finally, pertinent Germany specifications emphasize the importance of the application of crushed coarse aggregate. They also contain detailed requirements concerning the strength, cleanness, durability, etc., of aggregate for bituminous paving mixtures (43).

MINERAL AGGREGATE FOR GRANULAR BASE COURSES

Requirements for Base Courses

The definition of the term "base course" is: the layer immediately under the wearing surface. This applies whether the wearing surface is bituminous or Portland cement concrete eight or more inches thick, or only a thin bituminous surface treatment. Thus, the base course is subject to severe loading, therefore the materials in a base course must be of high quality and construction must be carefully done (27).

McLaughlin points out that the tests which may be applied to aggregates can be classified either as those tests which are used for obtaining information concerning the suitability of an aggregate for a specific use; or as those tests that provide information useful in the design of the base layers in which the aggregate is employed (20).

Many publications are available which describe the desirable properties of the finished base course and those of the mineral aggregates used in granular base courses. For instance, Shea has the opinion that grading, amount of fine particles, and compaction are very important with respect to the quality of a granular base course (39, 40). Gray, based on several series of triaxial compression tests (10), concluded that the greatest *strength* and *rigidity* for a graded (granular) base course can be obtained if (a) the aggregate is uniformly graded and has the largest maximum size that can be placed without segregation; (b) the amount of material passing No. 200 sieve does not exceed 12 percent; and (c) material passing No. 40 sieve is non-plastic.

He also concluded that crushed gravel is better than rounded gravel, and crushed stone is superior to both; furthermore, blending of crushed stone and gravel is a compromise. Huang and several other investigators have also found that the *particle shape* of the aggregate has a significant effect on the quality of a graded base course; more specifically, angular particles resulted in higher triaxial compressive strength (13, 14, 15). As Figure 2 shows, it is probable that this effect of the size and shape of particle is related to the increased internal friction between aggregate particles (6). Pertinent German specifications also emphasize the importance of the strength, particles shape, and grading of aggregate for granular base courses (23, 35, 36).

If a base course fails, the reason for this could be that the aggregate was weak or segregation occurred during the construction (33). In other cases *secondary* or *alteration* minerals were found in the rock used in bases that failed under use. The most common of these are kaolin clays, chlorite, serpentine, calcite, and limonite. Microscopic studies indicate that less than 20 percent of secondary minerals in a fine aggregate will have little effect, but more than 35 percent will almost certainly cause failure (38).

In California, bases and subbases were failing due to an excessive amount of clay-like fines. The aggregates used in these bases had complied with the normal requirements for grading, Los Angeles abrasion resistance, stability and content of clay-like fines. On some of the aggregates, specific gravity, absorption, soundness and cleanness tests had also been conducted. It was suspected at first that the excessive fines had intruded from the basement soils, but later it became apparent that some of the fines had resulted from *degradation* of the coarse aggregate used in the construction. The Durability Index Test was developed to predict the occurrence of fines due to degradation and subsequently replaced in Los Angeles Rattler Test in the California specification. Beaton, in describing the test, writes that "... it appears that materials with a Durability Index above some limit will always produce a satisfactory Sodium Sulfate soundness value, and hence, it would not be necessary to test these materials by use of the Sodium Sulfate Test." (1) Melville reports similar failing in Virginia (22).

Specifications usually contain special requirements for base course aggregates. These may require that aggregate contain a limited amount of flat or elongated pieces, that slag have an adequate density, or that aggregates used in bituminous mixes pass a certain stripping test. Some specifications contain service requirements whereby aggregate which do not pass all requirements may be used if they have a good previous service record or conversely, aggregate which pass all tests but have a poor previous service record, may be rejected (21).

Willis and Kelly made a comparison of the specifications of many states to determine requirements for aggregates used in water-bound

TABLE 2. Range of state specifications in 1948 (48)

Source	Deleterious Substances	Wear, Los Angeles Abrasion Max. Percent		Wear, Deval Abrasion Max. Percent	Soundness Loss Max. Percent
		Waterbound Macadam (Crushed Stone, Crushed Slag, and Gravel)			
ASTM Specification D 694-44	Reasonably free	Surface 40	Base 60	----	----
Range in State Highway Specifications, %	0-5	40	65-70	6-10	5-10
		Crushed Slag and Crushed Stone Base Course			
AASHO Specification M 75-45	Reasonably free	----	50	---	12[a]
Range in State Highway Specification, %	0-10	---	35-70	5-15	5-20

[a] Crushed Stone.

macadam and graded soil-aggregate bases and surfaces (48). Some of the pertinent results of their investigation are summarized in Table 2.

Sand-Equivalent Test

Certain substances which are more or less frequently present in coarse aggregates can be harmful to the performance of a base course. Usually, the amounts of these harmful substances are controlled by specifications which place a limit on deleterious substances. Some specifications name each substance and give the limit as a percentage by weight of the coarse aggregate. Others simply state that aggregate shall be free from deleterious substances (21).

The presence of harmful amounts of *clay-like* fines may be detected through one of the pertinent standard tests. The most suitable test seems to be the Sand Equivalent Test, developed in California by F. N. Hveem. This test ". . . tends to magnify or expand the volume of clay somewhat in proportion to its deterimental or objectionable effects." (16). The test is a rapid field measure which requires relatively simple apparatus.

In developing the Sand Equivalent Test, it was hoped that a correlation could be established with the stability of the aggregate layer. A correlation does exist, but it is not sharply defined throughout the range of sand equivalent values. The reason for this, according to Hveem, is that there are five factors affecting the stability of a soil and the sand equivalent value is a measure of only one of these; namely, the relative volume of the clay-like fines. It was established, however, that when the sand equivalent value is greater than 30, the clay fraction is not large enough to have much influence on the resistance value of the soil. A graph of the correlation between the sand equivalent values and the stability (Resistance Value) of various soil-aggregate mixtures is shown in Figure 3 (16).

In evaluating the Sand Equivalent Test for the Arizona Highway Department, O'Harra found the test well suited for detecting the presence of excessive clay or minus 200 material in aggregate (28). He showed a correlation between the SE sand equivalent value, the minus 200 materials and the PI plasticity index of the binder. O'Harra's data was presented in the form of eleven graphs, each representing a certain range of sand equivalent values. The extreme cases where the sand equivalent values are 0-9 and 80-100 are shown in Figure 4. The intermediate ranges generally fall somewhere between these extremes. On the basis of his tests, O'Harra classified aggregate according to its sand equivalent value as follows:

Sand Equivalent	*Quality of Materials*
0-14	Unsatisfactory
15-24	Doubtful, but usually unsatisfactory
25-34	Doubtful, but usually satisfactory
35-54	Almost always satisfactory
55-99	Satisfactory

The Sand Equivalent Test has been evaluated for use in South America as well as in the United States. Duarte and Marchetti suggest that, in addition to correlating with the stability of the aggregate, the test will correlate with the degree of alteration of rocks, proportion of finely divided materials, and the activity of soils (8). The Sand Equivalent Test has been accepted by AASHO as T 176-56.

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Irregularities In Surface Tension Measurement

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Surface tension is an important physical property of a liquid. Some of the factors that limit the precision of its measurement will be considered. The duNouy method of measurement is herein considered to be more precise than the capillary rise method. The reason is that capillary diameter, even with precision bore tubing, may vary more than the inherent precision of the duNouy method. Also, the problems of capillary contamination must be considered. However, reproducible results are difficult to achieve with a commercial duNouy tensiometer. In the measurement a circular platinum wire probe is broken away from the liquid surface in about ten seconds. It is easy to show that the surface tension measurement depends upon this time of measurement or film stretching. Therefore, a procedure must be found to provide a measure of the surface tension under reproducible conditions.

TENSILE RUPTURE OF SOLIDS AND LIQUIDS

Many solids have ultimate strengths that are higher than their proportional limits. A stress-strain diagram is a straight line up to the proportional limit in a usual case. Then the slope of the stress-strain diagram decreases until it is zero at the ultimate strength. Most non-brittle solids do not break at this point, but "neck down" without further stress and then break.

Based upon this solid comparison it may be suggested that the surface tension of a liquid corresponds to the breaking strength of the stretched film. Two questions may be considered. Does a liquid behave like a solid in that the stress-strain diagram is not linear beyond the proportional limit? And, does the liquid film break when the ultimate strength is reached, or at a later time?

Since a liquid has diffusional properties that are greater than for solids, any non-linearity of the stress-strain diagram may not occur until very close to the ultimate strength. Actually the suggestion that a liquid behaves like a solid is just an approximation, since it is not known what is actually being measured in a surface tension test. But the measurement is definitely a function of time. The duration of time for a measurement may be varied over a range, perhaps 0.05, 0.5, 5, and 50 minutes. The duration of time is important for highly viscous liquids and solutions that approach equilibrium very slowly or when no equilibrium is practically possible. In addition, it would usually be noted that statistical variations occur for the measurements at long times of film stretching, which are indicative of local temperature and concentration fluctuations.

In answer to the second question above it has been found that the stretched film breaks after a maximum balance reading occurs. This was observed for water and organic solvent solutions. This is, perhaps, the central idea behind the method of design that will be proposed here. It is possible to reverse the stretching force after what might be called the liquid ultimate strength is reached in time to prevent film rupture. Such film rupture causes the spurious readings obtained with commercial tensiometers.

MECHANICAL DESIGN

Although forces smaller than a microgram may be measured, control problems are so difficult that this may be regarded as a practical limit. Ever since the commercialization of the substitution-type analytical balance various uses have been found that require the almost instantaneous readings that are possible. The equipment is constructed so that the weight of the duNouy probe and the hangdown is about the same as the weight of the pan assembly that is removed from the commercial balance. In this way a calibration reading may be made prior to contacting the liquid surface.

Some commercial microbalances have ranges of about 20 grams. Therefore, ten grams may be used as a design value. For a liquid with a surface tension of 100 dynes per centimeter, the probe would be six inches in diameter. It is possible to machine a six inch tube to an accuracy of 0.001 inches. But if accuracy is abandoned, the precision of the probe construction will be comparable with the microbalance precision, if the same probe is used for all measurements. The probe itself may be machined to a V-edge. Therefore, mechanical considerations alone would limit the precision to seven significant figures.

CONTROL AND CALIBRATION

Based upon an analysis of surface tension data in Lange's handbook (1), the negative change of surface tension with temperature is not greater than 0.2 dynes per centimeter for each Centigrade degree, if liquid metals are omitted. If it is possible to control the sample temperature to 0.001 Centigrade degrees, the microbalance fluctuations would be expected to vary about 20 micrograms for a six inch diameter duNouy probe. It is interesting to inject the speculation that a film stretched to perhaps 95 per cent of its breaking strength would be an extremely sensitive thermometer. It might be possible to note a 0.0001 Centigrade degree fluctuation, which would correspond to about a two microgram change on the balance.

But factors other than temperature control cause much greater fluctuations. When a liquid is stretched a local adiabatic cooling occurs that is greater than 0.001 Centigrade degrees. This cooling depends mostly upon the speed of the film stretching. It is this factor that causes most of the variations observed in practice. The best way to correct for this factor is to vary the range of measurement times from perhaps 0.05 to 50 minutes.

Another factor that must be controlled is the vapor concentration in contract with the liquid surface. Air produces variations that make precise work difficult. While the best vapor would be that corresponding to the vapor-liquid equilibrium condition, this is not practical because of the possibility of condensation on the duNouy probe that is above the liquid surface. A good compromise involves the use of helium, which does not dissolve in most liquids very much. Of course, any gas will produce a determinant effect on a surface tension measurement.

If the above factors can be controlled, six significant figures precision appears to be possible. However, corresponding surface tension accuracy is not possible, since it is not possible to correct for the weight of the liquid in the stretched film this accurately. An arbitrary standard must be chosen. The surface tension of water purified in a certain way and saturated with helium would serve this purpose.

LESS PRECISE WORK

For less precise work a microbalance is not necessary. A substitution-type analytical balance precise to 0.0001 grams is adequate. Simple temperature control and measurement to 0.01 Centrigrade degrees are sufficient. The measurement should be made in a controlled atmosphere, such as helium. The times of film stretching may be varied using a series of gears to drive a motor, which controls a micrometer screw that lowers the sample. A linearity calibration of the stress-strain diagram may be made using an optical lever system, after which any deviation from a linear behavior may be determined by the balance readings. That is, these readings should be made by eye or by taking photographs at predetermined

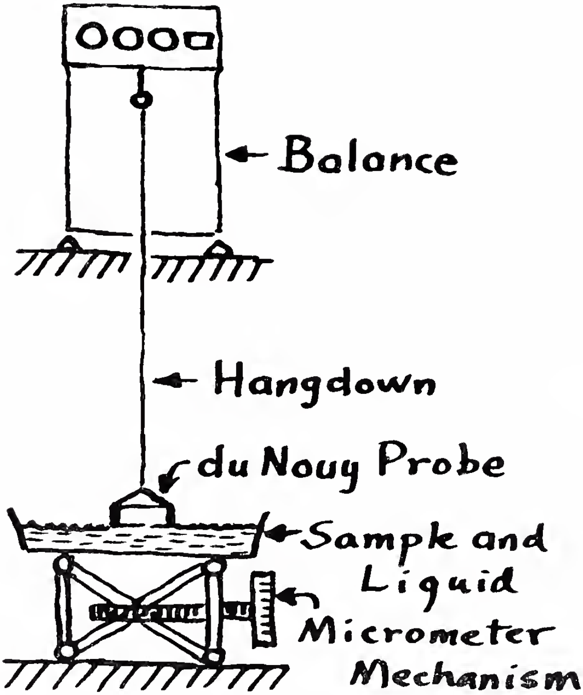

FIGURE 1. Measurement of Surface Tension with a Substitution-Type Balance. The balance is isolated from the duNouy probe and sample by a hangdown. The micrometer mechanism lowers the sample container until the maximum balance reading is obtained, which corresponds to the surface tension for the particular conditions selected.

time intervals. Most measurements of surface tension are precise to three significant figures. The use of a substitution-type balance and the suggested means of measurement has an ultimate capability of five significant figures providing all the variables and parameters are investigated.

MEASUREMENTS

In order to check the principle of this design a liquid sample controlled to 0.1 Centigrade degrees in air was contacted with a 1.5 centimeter diameter probe. It was found that the greatest fluctuations were caused by variations in the film stretching time. As suggested above the liquid film broke after the ultimate strength was reached. A manuel micrometer screw that lowered the sample could be reversed to prevent the film rupture even five seconds after the maximum balance reading occurred for water solutions near room temperature. Air appeared to cause a lowering of the surface tension with waiting time after the sample was poured. This may be a result of oxygen adsorption, but it is more probable that it is a preferred orientation effect that occurs in interphase regions, as previously suggested (2). It was observed that the effect is about 10% greater in D-glucose and rat liver glycogen solutions than in pure water, which points to orientation energy. Also, the same result is obtained in air saturated solutions versus freshly poured solutions from a bottle with a helium atmosphere.

SUMMARY

The measurement of surface tension to five significant figures may be possible with a substitution-type analytical balance using a six inch diameter duNouy probe. This probe may be leveled by means of an attached bubble tube and some attached adjustable counterweight screws. The probe may be isolated from the balance by a hangdown as shown in Figure 1 to keep the sample temperature controlled (not shown). Also, a helium or nitrogen atmosphere is suggested. It is necessary to vary the stretching time over a wide range in order to obtain useful theory from the work. This would depend upon the system under consideration. Statistical variations occur in samples stretching in long times, and these varieties are greater for highly viscous liquids and solutions in which diffusion is slower than in ordinary liquids. It should be evident that surface tension is not a simple measurement, and a number of factors contribute to the limitations of its measurement. This is a field that is rather poorly explored.

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Market Values And Transfers Of Milk Quotas In Alabama

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Seasonal milk pricing plans have been used for many years to provide incentives for producers to reduce seasonal fluctuation of milk delivers. Since the 1930's, the Alabama Milk Board has utilized a series of base-excess plans as encouragement to dairy farmers to supply quantities of milk that were reasonably in line with the demand for fluid milk. The basic logic behind any base-excess plan is that each producer establishes a "base" by deliveries made during the fall or winter months (or both) when markets tend to be short of milk. Farmers who establish large bases during the base-forming period gain a greater claim to the market in succeeding months than farmers who sell less milk in the base-forming period. Base milk is priced relatively high compared to excess, or surplus milk, which is all milk a farmer delivers in excess of his base.

In Alabama, bases are transferable and since a base is, to an extent, a license to sell milk in the fluid market, a negotiable base has monetary value. Since 1960, approximately one-third of the Grade A milk producers in the State have purchased base or quota,[1] mostly from dairymen who were ceasing Grade A production.

During the past few months, we made a study of the market for Grade A milk quotas in Alabama. The objectives of the study were to determine the conditions of transfer, number and volume of transactions, prices paid, and factors affecting the value of quotas transferred in Alabama, and to develop procedures for estimating the market value of quota in the State under alternative market situations.

A list of producers who bought and sold quotas since 1960 was assembled from records made available by the Alabama Milk Control Board. The study period selected was January 1961 through August 1964. Of the producers in business in 1964, 387 purchased base during this 44-month period. A systematic sample of 6 quota purchasers shipping to each of eight plants, selected on criteria of number of quota transfers, market area and type of quota plan used, was drawn. A questionnaire was developed and personal interviews were obtained from 39 dairymen to determine prices paid for quota and factors related to purchase of quota. Other characteristics of producers were obtained from a 1964 survey of 800 dairy farmers.

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[1] Technically, "base" plans are based on production while "quota" plans are based on sales. In this report, the words quota and base will be used synonymously. This usage of the terms is implied in the rules of fair trade practices of the Alabama State Milk Control Board, and is an accepted practice of personnel connected with the dairy industry in the State. Actually, there are in use in Alabama one base plan and two base-quota plans.

QUOTA PROVISIONS IN ALABAMA

Two main quotas plans are used in Alabama. These two quota plans are the "plant usage method" and the "alternative quota plan." Under the plant usage method all milk delivered by a producer to a distributor during the base-building period, September through February, is used in calculating the producer's quota. Each producer's quota is the ratio that his deliveries of milk during the base-building months are to total deliveries during this period. Quotas are used to allocate producer receipts. For example, a producer who owns a quota of 10 per cent is entitled to receive payment for 10 per cent of his plant's sales of Class I and II milk. Quotas remain effective for one year beginning on the first day of March. Rapid quota adjustments among producers are possible under the plant usage plan.

Under the alternative quota plan, quotas are tied more closely to plant sales. Although the same base-building and base-using periods are used under this plan, the quantity of producer's milk used in calculating his new quota cannot exceed 115 per cent of his share of plant Class I and II sales. Due to the relative ease of maintaining quota under this plan, it can properly be referred to as a "semi-frozen" base plan. The only sure way for a producer to expand quota under the alternative plan is to purchase additional quota.

Present regulations of the Milk Control regarding transfer of quota are quite lenient. In general a quota is deemed to be the personal property of a producer and may be sold or transferred in almost any manner as an incident to the sale of the producer's herd. The base may be divided and sold to several persons. Purchase of a seller's cattle is not a requirement for buying quota.

QUOTA PURCHASERS MADE PRODUCTION ADJUSTMENTS

There are two primary causes of the active market for quotas in the State. First, in 1961 the Alabama Milk Control Board eased the restrictions regarding quota transfers. Second, there have been major shifts in the market structure of the milk industry. A study of 1,656 Alabama dairymen who sold milk in 1959 revealed that by 1964, 667 had quit production, while only 212 new producers entered the market. On the other hand, average sales per producer rose 52 per cent during this 5 year period.

Almost all of the producers who left production sold their quotas, either to dairymen who were already in business and were trying to increase sales or get a higher price for their milk, or to new producers. In a four-year period beginning January 1, 1961, 516 milk quotas were sold.

Analysis of milk sales records of Alabama dairymen for the 1959 and 1964 base-building periods revealed that the 387 producers who bought quota sold considerably more milk on the average than the 814 producers who had not bought quota, Tables 1 and 2. Average daily sales during the 1964 base-building period were 1,791 pounds and 1,136 pounds for the buyers and non-buyers, respectively. Purchasers of quota who produced milk in both periods sold more milk than non-purchasers in 1959 as well as in 1964. Average per centage increase in production between 1959 and 1964 was also much higher for the purchasers. About half of the 212 new producers in the market since 1959 had purchased quota during the study period. Data obtained from a recent survey of 800 Alabama dairymen revealed that a higher percentage of the producers who bought quotas followed good management practices, such as production testing, artificial breeding, and silage feeding, Table 3.

QUOTA PURCHASERS PAID WIDE RANGE OF PRICES

Producers who bought quota paid a wide range of prices, Table 4. The 39 producers who were interviewed paid from $160 to $7,200 for quota. The amount paid for quota was converted to price per 100 pounds of Class I eligibility. For plant usage quota, this figure is the number of pounds of Class I that the purchased quota enabled the buyer to sell divided by total cost. For the alternative quota plan, it is based on number of pounds of Class I that the quota would enable a producer to sell within one year from date of purchase. The one year period was used because of the relative ease by which producers can maintain quota under the alternative plan. These prices may be compared with the difference in Class I and Class III price, approximately $3.44, as an estimate of potential producer outcome on quota purchasers.

Price per 100 pounds of Class I eligibility ranged from $.39 to $1.96 for plant usage quota. Price per 100 pounds of Class I eligibility acquired within one year from date of purchase ranged from \$.54 to \$7.29 for quotas bought under the alternative quota plan. The wide range in prices paid for quotas is probably due to several factors, including bargaining ability to levels of knowledge of buyers and sellers about quota regulations. The wide range in prices for alternative plan quotas reflects differences in buyers' planning horizons, i.e., the length of time they were willing to wait to recover investment.

There are two other factors leading to variations in prices. In one sense, a seller's market exists. When a quota becomes available, potential buyers may be eager to obtain it, because they know they will not have another opportunity to purchase base until another producer at their plant retires, quits the business, or dies. This could conceivably result in a wait of several years before another opportunity was presented. On the other hand, a seller of quota is probably more interested in receiving a good price for his cattle, equipment, and perhaps his farm than he is for his quota. He may sell his quota cheaply in order to obtain a good price for his other assets.

TABLE 1. Adjustment in average daily sales of 989 dairymen, by purchase of quota. Alabama, 1959-1964

Time quota was bought	Dairymen	Average Daily Sales		Increase in Average Daily sales	
		1959	1964		
Number	Number	Pounds	Pounds	Pounds	Per cent
0	699	814	1,155	341	42
1	202	998	1,637	639	64
2	67	1,239	2,196	957	77
3	14	1,875	3,058	1,183	63
4 and over	7	1,223	2,982	1,759	144
All dairymen who bought quota	290	1,101	1,867	766	70
Total	989	898	1,364	466	52

TABLE 2. Average daily sales of 212 dairymen who entered production after 1958, by purchase of quota. Alabama, 1963-1964

Times quota was bought	Dairymen	Average daily sales in 1963-1964
Number	Number	Pounds
0	115	1,017
1	64	1,349
2	21	2,001
3	7	1,859
4 and over	5	2,038
All dairymen who bought quota	97	1,563
Total	212	1,266

TABLE 3. Selected characteristics of 778 dairymen, by purchase of quota. Alabama, 1963

	Farmed 200 acres or more	Milked more than 50 cows	Increased herd size in 1963	Were under 45 years old	Had predominately Holstein herds	Sold more than 70% of milk as Class I	Used production testing	Used artificial insemination
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Bought quota	46	84	62	48	66	74	53	71
Did not buy quota	37	62	37	37	57	64	42	66

TABLE 4. Amounts paid for quota, prices per hundredweight of Class I elibility and minimum months required to regain investment in quota, 50 quota transactions at 8 plants, by quota plan. Alabama, 1961-1964

Quota plan and plant	Transactions studied	Amount paid per transaction			Price per 100 lb. of Class I			Minimum months to regain investment		
		Low	Average	High	Low	Average	High	Low	Average	High
	No.	Dol.	Dol.	Dol.	Dol./Cwt.	Dol./Cwt.	Dol./Cwt.	Mo.	Mo.	Mo.
Plant usage	24	160	1,131	3,900	.39	.95	1.96	1.0	2.6	6.3
Plant A	4	900	1,742	3,500	.73	.78	1.00	1.5	2.3	2.7
Plant B	11	160	624	1,000	.39	.95	1.71	1.0	2.4	4.0
Plant C	3	290	1,287	2,220	.97	1.23	1.52	2.7	3.5	4.7
Plant D	6	525	1,704	3,900	.51	1.00	1.96	1.5	2.9	6.3
Alternative	26	375	1,811	7,200	.54	1.82	7.29	2.0	6.9	25.0
Plant E	10	375	771	1,450	.54	.69	1.11	2.0	2.8	4.0
Plant F	6	1,000	2,250	4,000	1.18	2.29	3.37	4.5	8.7	11.5
Plant G	3	750	750	750	1.26	1.26	1.26	5.0	5.0	5.0
Plant H	7	1,400	3,374	7,200	2.21	3.41	7.29	7.5	11.8	25.0

PURCHASERS MADE GOOD INVESTMENTS

Average minimum number of months required to regain investment in quota was 2.6 months for the sample plant usage transactions and 6.9 months for the same alternative quota transactions. While only 15 of the 39 purchasers gave an estimate of the number of months they though necessary to regain the purchase price, 10 of the 15 estimated within 2 months of the calculated minimum number of months required.

Most of the farmers interviewed had received assistance in calculating price to pay for quota. Personnel at the producers' plants were the most common source of assistance.

The majority of the sample group said that they purchased quota either to raise blend price, to increase size, or both. Although about three-fourths of the dairymen stated that they made a good buy on quota, only about a third said that they would definitely attempt to purchase more quotas in the future.

A GUIDELINE FOR ESTIMATING THE VALUE OF MILK QUOTA

It was found that only 10 of the 39 dairymen interviewed had calculated the probable value of the quota prior to purchase. By following the general steps listed below, a producer who is considering the sale or purchase of base can obtain a reasonable estimate of the value of quota.

1. *Be familiar with regulations of the Milk Control Board that affect quotas*

Since producer incomes are affected by these regulations, it is economically important that producers become familiar with pertinent regulations, not only for the purpose of quota purchase, but also as a means to become better equipped to make routine production and marketing adjustments.

2. *Convert the quota from a percentage to its monthly equivalent in Class I milk*

Often, producers obtain assistance from personnel at their distributor's plants in arriving at this figure. However, a producer can obtain this information from his milk check stubs. By dividing the amount of Class I sold in a month by his earned quota, he can determine approximate plant Class I sales — as long as he overshipped his Class I allotment. Select a reasonably typical month to make this computation and double-check against other months. Next, multiply plant Class I sales times the percentage of quota for sale.

3. *Compare monthly Class I equivalent with monthly Class III expected, (assuming quota is not purchased)*

If about the same or more surplus per month is expected, go on to Step 4. If less surplus is anticipated, either use amount of Class III to calculate quota value, or attempt to buy a smaller amount of quota.

4. *Multiply by the difference in Class I and Class III price to obtain monthly value*

The current Class I price is $6.56 and Class III prices have ranged from $3.12 to $3.33, thus this difference has ranged from $3.44 to $3.23 in recent years. Dairymen who receive little or no surplus, yet sell large amounts of government contract milk can multiply times the difference in Class I and Government price, or

$1.81 cwt. A producer who is expanding production must take into consideration the effect of expansion on his marginal cost in determining price to pay for quota.[2]

5. *Determine the total value of the quota*

This figure can be obtained for plant usage quota by multiplying monthly value times the number of months remaining until the last day of February. Purchases made during the base-building period usually have an income producing value beyond one year because the seller's deliveries during the current base-building period are credited to the purchaser. Prospective alternative buyers may wish to expand the monthly value by 12 or more months. See Step 6 for factors that should determine the buyer's planning horizon.

6. *Discount for risk and uncertainty*

Eliminate any receipts that cannot reasonably be expected to be forthcoming. Keep in mind that quota provisions may suddenly be changed, and that all or part of the quota may be lost in the suceeding base-building period.

7. *Discount the expected future receipts to their present value*

This step can be accomplished by simply discounting at a rate of 6 per cent per year compounded annually, although this method overstates the discount somewhat. The following formula may also be used:

$$P = \frac{v}{r}\left[1 - \frac{1}{(1 + r)^n}\right]$$

where P is present value, v is the future value, n is length of time and r is the interest rate (use .5% monthly or 6% annually).

At any price below the value calculated in these 7 steps, quota would probably be a money-making investment. The approximate profit would be the difference in purchase price and the value calculated. Remember that the longer one is willing to wait to regain his investment; the larger is the price he can afford to pay, but also the greater is the risk that he takes.

CONCLUSIONS

Answers given on the producer survey and responses given by some producers when interviewed lead to the conclusion that many producers are not familiar with quota regulations used in the State.

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[2] Hoepner, Paul H. Optimum Levels of Milk Production Under Marketing Quotas. *Journal of Farm Economics* 46:567-579. 1964.

Due to the effect these regulations have on producers' incomes, it is economically important that producers become more familiar with pertinent regulations, not only as a prerequisite for purchasing quota, but as a means of becoming better equipped to make ordinary year-to-year production and marketing adjustments.

On the basis of the sample, it appeared that Alabama dairymen placed a high discount on the value of quota. This high discount seems to have led to the purchase of quotas at low prices relative to their potential value. Most producers who have purchased quota have been able to boost sales cheaply. It appears that Alabama dairymen have generally been able to increase quota more cheaply by purchasing rather than by building it.

A further reduction in number of Grade A milk producers in Alabama is expected for the next few years. Barring any drastic revisions in regulations affecting quota transfers, as active market for base will continue in the State.

The Lunar Crust

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Whether or not the moon possesses a low-density, sialic crust, similar to that existing under the continents on the earth, may have an important bearing on the kind of materials found on the moon, the types and depth of mineralization and the selenographic distribution of the mineralization.

The presence of the earth's crust is attested to by the contrast in seismic properties and composition of its igneous rocks to those that must make up the denser mantle. The seismic properties also serve to locate the crust-mantle interface (Mohorovicic discontinuity) and thus, the crustal thickness. The crust underlies the ocean as well as the continents, but this crust apparently is thinner and more basic than under the continents. The basaltic oceanic crust is believed also to underlie the granitic continents at about 17.5 km average depth.

Heiskanen and Vening-Meinesz (1958) made a distinction between the crust above the "Moho" (M crust) and the rigid crust which lies above the plastic mantle. They believed that on the continents the bottom of the rigid crust may coincide approximately with that of the M crust (30 km), but that its boundary under the oceans must be below the basaltic layer and thus within the ultrabasic upper mantle.

There are several current theories regarding the origin of the earth's crust and to explain its contrasting chemical composition to that of the assumed ultrabasic mantle. Among the theories are the following:

1. A primitive crust or "sialic scum" was formed by differentiation of the upper mantle in the very early history of the earth when a completely molten earth began to cool. Subsequently further differentiation and the melting and gathering of foundered sialic crustal sections, resulted in evolution of the continental and oceanic crusts of geological times.

The entire crust originally may have been basaltic with no initial differentiation into granite and more basic rocks. "Localized fractures in this initially-thin basaltic crust would channel lava, hot gasses and solutons from the hotter subcrustal layers and these fractures would provide nuclei (something like the present-day island arcs) for the nascent continents. The action of solutions carrying silica and alkalis would produce less basic crustal rocks.

Erosion and sedimentation, at first on a small scale, would accelerate the chemical differentiation of crustal material." (Mason, 1958).

2. A crust formed gradually over the earth's history as differentiation of material from local, shallow and partial melting occurred as a result of radioactive heating. The processes cited by Mason, above, may have assisted the separation of the more acid, granitic continents. This idea would not require that the earth ever to have been completely melted.

3. The crust, particularly the more granitic continental crust, was accreted by the earth from the moon, from a hypothetical second satellite, or from asteroidal material, near the end of the earth's growth by accretion (Alfven, 1963; Donn, et al, 1965; Howell, 1959).

All three of these crustal-forming mechanisms could have, under the proper circumstances, been possible for the moon. No one, however, has proposed the third mechanism. In a sense, it could be said that one theory of the origin of the maria (Urey, 1952), whereby the bombardment of the lunar surface by meteorites resulted in the melting of these bodies and of parts of the lunar surface to form the smooth maria, produced an external, partial lunar crust. This crust, however, covers only about forty percent of the side of the moon facing the earth and even less, of the averted lunar face (Barabashov, et al, 1961), and its composition is often assumed to be highly basic (dark color) and therefore, possibly denser than the original lunar surface material. Most students of selenology, however, consider the maria to be of endogenous origin.

Little or no specific discussion of a possible lunar crust is found in the literature. In most cases the existence of a lunar crust is assumed, but it is evidently defined merely as the outer zone of the body and not necessarily as a distinct or differentiated layer. Seven references to the crust in NASA SP-7003 and NASA SP-7003(01), "Lunar Surface Studies: A Continuing Bibliography," carry no discussion of a lunar crust as such, to judge from the abstracts given. Two or three papers presented arguments for the presence of granitic rocks. These were largely attributed to extrusive volcanic action but not, apparently, to a differentiated crust, although this condition could be inferred.

The distinction mentioned above for the earth, made by Heiskanen and Venning-Meinesz (1953), between the concept of an outer layer differentiated from the underlying mantle and that of a solid, rigid crust above a soft or yielding mantle, could also apply to the moon to some degree. The principal differences in the two cases would result from the much smaller size and mass of the moon, if similar initial chemical compositions are assumed. Pressure at the center of the moon is estimated by MacDonald (1961) as only 46,000 atmospheres while at the center of the earth it is about 36×10^6 atmospheres (Mason, 1958) and at a depth of just under 2,000 km (radius of moon = 1738 km), it is about 0.8×10^6 atmospheres. As a result of these differences, the increase in melting points of silicates and of free iron would be much less from surface to center of the moon and consequently, softening would more readily occur with depth at a given temperature in the moon than in the earth. At equal initial temperatures, the earth should cool more rapidly than the moon because of its greater surface area, but as the earth is even more massive than the moon, its total heat content would be greater and its temperature would remain higher at the end of a given elapsed time. If the two bodies initially contained equal percentages, by weight, of radioactive substances distributed in the same way, heat from that source should be dissipated more rapidly by the moon.

MacDonald (1961) and Levin (1962) both have dealt with the thermal history of the moon. MacDonald's two lunar models (initial temperatures assumed to be 0°C and 600°C, respectively) have interiors at temperatures above the melting point of metallic iron from about 500 km on downward, but the melting point of the silicate diopside ($CaMgSi_2O_6$), while fairly closely approached at a depth of about 800 km, is not exceeded. In his hot moon, this melting point might reasonably be exceeded, especially if water or other substances that tend to depress the melting points of silicates, are present.

MacDonald's assumptions were composition like that of chondritic meteorites, including radioactive element content, and with all elements homogeneously distributed throughout the moon. On considering external cooling combined with assumed radioactive heating, MacDonald concluded that the lunar radius has remained substantially consistant for both models after about 3×10^9 years ago or for the last 1.5×10^9 years. This confirms the lack of visible lunar surface feature displacements such as would result if there had been any significant radius changes since these features were formed unless they are older than 1.5×10^9 years. He proposed the hypotheses that the surface feature observations also can be explained by one of the following, the second two of which require inhomogeneous distribution of radioactive content.

1. The radioactive of the moon is less than that of chondritic meteorites.

2. If the lunar radioactive content is equal to that of chondritic meteorites, it is very deeply buried at sufficient depth.

3. The moon is a chemically differentiated body with the radioactivity concentrated near the surface.

Based on explanation 1, the moon has no differentiated crust, but may have a soft or melted interior beginning several hundred km below the surface.

No. 2 would require considerable melting at depth and probably would result in a moon still heating, but possibly with no chemically differentiated crust.

Explanation 3 assumes very early heating and melting, probably from extinct nuclides, like Al^{26}. Some later local heating near the surface might have occurred from concentrations of radioactivity. A differentiated crust is present but probably no soft lunar interior.

Levin (1962) makes substantially the same assumptions as MacDonald: meteoritic composition (but the word chondritic is not used), as initial surface temperature of 0°C and radioactivity that seems a little larger than MacDonald's for uranium and thorium, but somewhat smaller for K^{40}.

Levin's melting curves for "lunar matter" assume a melting range of 200° from initial to full. Initial melting at the surface was at 1470°K and at 1738 km, 1620°K (1200°C and 1350°C). The initial melting temperature is near that of MacDonald's diopside curve, but the central melting temperature is somewhat lower.

Under 3 sets of assumptions with different values for the lunar age (4.5×10^9 and 5.0×10^9 years), radioactivity content, and for absorption coefficients, Levin found melting beginning at 300 km depth in 2×10^9 years, but full melting was not attained, at any depth, in that time. Melting at the center began at $0.9\text{-}1.4 \times 10^9$ years for a 5.0×10^9 year old moon and at $1.3\text{-}2 \times 10^9$ for one 4.5×10^9 years old. Complete melting at the center in the older moon occurs at $1.5\text{-}2.4 \times 10^9$ years under various assumptions and in the 4.5×10^9 years old moon, not until 4.3×10^9 years.

Levin explains the differentiation process as follows: "The most fusible materials and eutectics should be the first to melt in the course of melting. As a rule, they are less dense; apart from that, the volume increases in melting resulted in an additional decrease in their density. Therefore the molten matter must have moved upward, seeping between the particles which remained solid. These solids, denser particles must have been striving downward, squeezing out the molten matter to the top. As a result, a differentiation in density and chemical composition took place, which changed the distribution of melting temperature along the radius." This process, he points out, transferred much heat upward, producing the same effect as increased conduction. As the light fusions and the radioactive materials moved upward they should have intensified partial melting of the outer layer and delayed or even stopped that of the central part. Thus, the lunar interior may never have attained complete melting. The most favorable place for complete melting may have been at the base of the outer layer.

Levin next turned his attention to cooling which he assumed to have begun at lunar age 1.5×10^9 years. He also assumed a layered moon of 1/7 lunar mass iron core, with low U and Th contents and no K^{40}, a mantle with slightly greater radioactivity values than meteoritic and a crust 10-17 km thick made up of 1/3 graphite and 2/3 basalt by volume and having a greatly increased radioactive content.

Levin's conclusion is that the moon is now solid to a depth of 500-700 km. Thus, his picture is that of a graphic-basalt, 10-17 km thick, differentiated crust on top of a rigid crust 500-700 km thick.

It is not surprising that we can reach no concensus regarding a lunar crust when we have not as yet reached a unanimous one regarding that of the earth. Urey (1962) has long refused to accept the old idea that the earth *must* have been molten at one time. It is not strange that he should do so regarding the moon. MacDonald appears to "lean" toward an undifferentiated moon not quite as obviously as Levin "leans" in the opposite direction! Apparently, there are few or no "cold moon" advocates among Russian scientists, including those who may advocate "cold accretion" origin theories. Among Americans are both kinds.

Recently Donn, et al (1965) have questioned the possibility that the continents could have been formed by upward migration of K, Na, Al and Si; and the downward migration of Ca, Mg and Fe, in a cold accreted earth of chondritic composition. They maintain that there was not enough time for primitive continents to have so formed by 4.0 billion years ago as indicated by the geological ages of older granitic rocks, in a 4.5×10^9 year old earth. They favor, instead, an external origin for the primitive continents from low density meteoritic matter. If this is true for the continents of the earth, the very old present lunar surface (Shoemaker, et al, 1963) also could hardly be differentiated.

It seems clear that if one accepts early and complete melting of both the earth and the moon, both bodies should be rather thoroughly differentiated. Urey (1962) has pointed out that this should also have resulted in virtually complete devolatilization, an unlikely condition for the still degassing earth and even for the moon because of Kozyrev's observations (Alter, 1959). In the case of the moon, the apparent great age of its present surface features (Shoemaker, et al, 1963) suggests that any differentiation present must be attributed to very early melting. If early melting by short-life radioactivity is ruled out, it is highly unlikely that the moon could have become differentiated by the slow process of migration upward of light elements, as is possible for the earth. There simply would not have been enough time for such migration to have effected differentiation before the rigid crust became too thick to permit it, as evidenced by the observed lack of lunar surface displacement features.

A low density crust of external origin for the moon has no support from observed facts or from theoretical considerations.

It seems fair to say that unless there was an early complete melting of the bodies in the inner solar system, the moon is not likely to be chemically differentiated to an extent approaching that of the earth and it seems equally certain that there is a rather thick rigid shell of at least 25 to 40 percent of the lunar radius. This solid shell will comprise 78 to 58 percent of the lunar volume.

If there is little or no overall crustal differentiation on the moon, extensive mineral deposits are not likely on the lunar highland. If, however, the maria are of endogenous origin, the interface between the maria and the highlands and fractures and other structural features within the maria, might well be mineralized by and with trapped volatiles (Salisbury, 1961, 1962).

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ABSTRACTS

Biology

Specific Gravity Of Root-Knot Nematode Egg Masses

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The root-knot nematode is a widespread parasite of plants, thus it is important to be able to assay for this parasite in the soil. Methods for extracting infective larval stages for the soil are available, but no routine method has been developed for extracting unhatched larvae retained in egg masses. The specific gravity of the egg masses was used as a basis for a flotation technique for extraction from soil samples.

Egg masses of *Meloidogyne hapla* and *M. javanica* were collected from the root systems of tomato plants grown in a greenhouse. Egg masses were separated into three categories on the basis of their coloration, which is related to age of the egg mass, and size. The specific gravity of each egg mass was determined in a series of sugar solutions of known specific gravity. Specific gravity data of the egg masses were not appreciably different between nematode species nor appreciably affected by age or size. However, variability in specific gravity was noted within the color and size groups. Some variability was due to the kinds of foreign particles adhering to the egg masses, buoying or weighting the egg masses. Differences appeared also to be related to the number of unhatched eggs present in proportion to the size of the egg mass; the more eggs present the heavier the egg mass. A sugar solution of 1.400 or greater specific gravity is indicated for egg mass extraction to cope with the specific gravities encountered, which ranged from 1.100 to 1.400.

Relationship Of Environment To Growth And Aflatoxin Production By *Aspergillus flavus* In Stored Peanuts

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The effect of temperature and relative humidity (RH) on growth and aflatoxin production by *Aspergillus flavus* was studied with heat-sterilized, shelled and unshelled peanuts stored after inoculation in eight 10-ft^3 environmental cabinets at temperatures of 5-55 ± ½ C and RH from 55-99% ± ½%. Peanuts were sampled after 21 days incubation and the per cent kernel moisture and aflatoxin content were determined. *A. flavus* grew well at 14-43 C and 97-99% RH. Aflatoxin developed in peanut kernels at 14 and 40 but not at 12 and 43 C. Aflatoxin levels of 127-364 mg/kg were produced in both shelled and unshelled peanuts at 20, 25, 30, and 35 C. *A. flavus* grew well at relative humidities of 86-99% at 30 C. Aflatoxin developed in peanut kernels at 86% but not at 85% RH. Aflatoxin levels of 40-90 mg/kg were produced in peanuts stored at 89% RH and above. There appeared to be little difference between aflatoxin levels in shelled peanuts and those in the kernels of peanuts with intact shells.

Seed Microbiological Research In Environmental Chambers

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Research on the limiting environmental conditions for mycotoxin production and seed deterioration in peanuts by fungi is being conducted in eight individual constant-temperature humidity cabinets. The 10-ft^3 working chambers have vertical airflow circulating over the humidifying water bath and heating coils. Continuous running, noncycling compressors provide refrigeration for low temperature and dehumidification. A self-contained water purification unit supplies demineralized water to each four cabinets. The unique feature of the cabinets is the dual, wet and dry bulb saturable reactor systems that provide precise proportional control of temperature from 5 to 90° ± ½° C and relative humidity from 40 to 99% ± ½% RH. Each unit is monitored by a 7-day recording psychrometer keeping an accurate visible record of performance. These cabinets have unlimited potential for microbiological research particularly with regard to production of aflatoxin by *Aspergillus flavus* and mycotoxins by other fungi on stored corn, cotton, cereals, soybean and other seeds as well for investigating the relation of temperature and relative humidity to physiological processes during curing and storage of seeds, foods, and feed stuffs.

The Orchids Of Honduras—A Preliminary Report

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Two collecting trips to Honduras in 1965 and 1966 have resulted in collections from 9 Departments. Ecological areas included arid semi-desert, central mountains and Carribean lowlands. Specimens were collected from hardwoods, pines, cacti, rocks and soil.

The collections have been returned to the Troy State greenhouse where they will be grown. Speciation and variation will be analyzed from living material. It is stressed that present collections represent only a promising start on a projected long-term study in depth of the orchids of Honduras. Supported in part by a grant from the Alabama Academy of Science.

The Production Of Electrical Energy And Protein Foods By The Means Of Biochemical Fuel Cells

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The process we used depends on the hydrolysis of woody substances by fungi and the recovery of one of these, "end," products, carbon dioxide, for the use by algae through the process of photosynthesis for their metabolism.

Research cells were constructed of transparent, plastic jars. These were divided into two approximately equal compartments by an asbestos membrane, which serves as an ionic bridge. In the anode compartment, a metal sponge was packed around with sawdust, which had been previously prepared by soaking in a solution of 8-8-8 commercial fertilizer. The sawdust was then inoculated with some species of Basidiomycetes fungi. The cathode consisted of a metal plate immersed in a solution of 8-8-8 commercial fertilizer to which a small quantity of sulfur had been added. This growth medium was then inoculated with a culture of atmospheric nitrogen fixing algae, *Cyanophyceae, Nostoc* or *Annebaena.*

The materials of which the electrodes were composed was found a factor in determining the efficiency of the cell. Research was undertaken to determine if the cell was functioning as a voltaic cell by making both electrodes of identical materials. Making the electrodes of an alloy of the following composition: (g.) C.05, Mn.34; P.026; S.014; Si.27; Cr.16.29; Cu.91; Iron 82.10; gave a potential difference of 0.8 to 0.9 volts. The best result so far obtained was a difference of potential of 1 to 1.25 volts with an anode of the alloy described and the cathode of zinc. The following were also found to be efficiency factors: Temperature 85° to 95° F.; Fungi: Basidiomycetes, wood substrate degree of saturation; Algae: Cyanophyceae; growth medium a degree of saturation. Electrodes: Research indicates the material of which the electrodes are composed have a catalyctic effect.

The Fungi-Algae Biochemical Fuel Cell is now developed to the point where it may be used to advantage in electronic devices in remote and undeveloped areas.

The production of protein food through the metabolism of algae is also feasible. The chief difficulty in algae production, the supply of an adequate source of carbon dioxide, has been overcome, by fungal hydrolysis of wood. The protein derived from the algae culture may be of vital importance to those geographical areas that do not lend themselves to its normal production by livestock husbandry.

Phenolic Acids In *Avena* Coleoptile

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Nitsch observed in 1961 that indoleacetic acid (IAA) in combination with certain phenolic acids (chlorogenic and caffeic) produced a synergistic response in first internode sections of *Avena.* Henderson and Nitsch in 1962 concluded that the synergism was due to the inhibition of indoleacetic acid oxidase by the polyhydroxy phenolic acids, whereas a monohydroxy phenol (cumaric acid) acted as a cofactor in this reaction.

Earlier investigators had shown that a monophenol, dichlorophenol (DCP), acts as a cofactor with the IAA-oxidase isolated from the pea epicotyl. Later it was shown that *Avena* coleoptile sections produced similar results on the destruction of IAA, except that in the latter case in addition to DCP another cofactor (Mn^{++}) was also required.

IAA-oxidase was isolated and characterized as the enzyme responsible for IAA destruction in the *Avena* coleoptile. The enzyme responded to the same inhibiting and accelerating factors as the coleoptile sections.

The current investigation proposes to isolate the naturally occurring phenolic compounds from the coleoptile to establish whether these endogenous factors are the same as those applied in the *in vitro* studies.

Using an extraction procedure designed to isolate phenolic derivatives from the coleoptile, certain substances were extracted and tested by chemical and physical techniques, as well as biological assay.

Chromatographic, ultraviolet and infrared methods showed that at least two compounds and their derivatives were present in these extracts. The derivatives of kaempferol and quercitin, their glycosides and cumaric acid were shown to be present. Further analyses are necessary to complete the evaluation.

Acidosis, Alkalosis and Calcium Metabolism In The Domestic Fowl

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Hall and Helbacka (1959) fed laying hens ammonium chloride and discovered that egg shell calcification was disturbed as a consequence. These workers believed this result to be caused by a lowered blood pH, but subsequent work has shown the depressed calcification resulted from induced metabolic acidosis. Freeman and Fenn (1953) and Schafer *et al* (1963) found that subjects allowed to inspire high levels of carbon dioxide displayed hypercalcification. Frank and Burger (1965) induced respiratory acidosis in laying chickens by exposing the birds to atmospheres containing above normal levels of carbon dioxide and found egg shell calcification to be improved as a consequence.

Egg shell calcification, therefore, should theoretically be improved by metabolic alkalosis induced by feeding sodium bicarbonate. Frank and Burger (1965) since the experiments described here were initiated, have reported that sodium bicarbonate in the drinking water of laying fowls did improve egg shell calcification, provided dietary sodium chloride was reduced.

This paper concerns the first report on the feeding of sodium bicarbonate to caged DeKalb 131 pullets, all of which received a basic corn-soy diet containing 3% calcium. Sodium bicarbonate was fed at levels of 1, ¾, ½, ¼, and ⅛ lb per 100 lb of feed. In experiments lasting 8 months, all levels of sodium bicarbonate significantly ($P<.01$) 1) increased egg production, 2) increased egg shell quality as assessed by specific gravity and thickness measurements, and 3) decreased egg weight.

Sodium bicarbonate in the drinking water did effect some improvement in egg shell quality, but egg weight was again depressed: however, in all experiments the loss in egg size was insufficient to cause a reduction in egg market grades. The improvements in calcification because of an increase in blood carbon dioxide or bicarbonate occur regardless of the blood pH.

Elimination And Utilization Of Poultry Waste Products

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The greater part of the broilers and eggs produced in the United States originate in the Southeast. These states are also producing an ever increasing portion of the nation's turkey meat and game birds. Alabama figures prominently in these enterprises.

The population of these same states is also rapidly growing. Man is more often finding himself being forced to associate more closely with farm animals since these enterprises frequently are located on the fringes of urban areas to minimize transportation. Problems involving disposal of both human and animal wastes, therefore, are increasing as are difficulties in the control of odors, flies, and disease.

The poultry farmer also finds it more and more difficult and expensive to obtain suitable litter materials and dispose of large quantities of poultry manure. Various techniques including use of water lagoons and mechanical manure handling equipment have proved of limited effectiveness. Recently a new method has been studied at Auburn in an attempt to solve the poultry manure problem.

Although dating back to antiquity, composting poultry litter as it occurs in the poultry house while in use is new. A culture of 46 species of micro-organisms was mixed into a base of peat and various minerals. This active mixture was spread at the rate of ½ lb/ft^2 of poultry litter that was at least 6 inches deep and contained an appropriate balance of cellulose and fecal material. Water used to clean the house interior was added to the litter, and then mechanically mixed to start aerobic action. After heat of composting had subsided, birds were placed on the litter.

Work to date indicates this process to be relatively inexpensive, overcomes problems associated with obtaining and disposing of litter; provides odor-free and fly-free environments; permits birds to be safely replaced on the same litter shortly after diseased stock has been removed or the houses flooded; permits humidification of poultry houses, thereby keeping dust to a minimum, enabling interiors to be washed, and thus increasing sanitation and equipment efficiency.

Experiments to discover initial and subsequent rates of application of the culture, disease carryover, and the nutritional value of the litter are in progress. The process is being used on a large scale by commercial poultrymen who are bagging the used odorless material for sale as a garden fertilizer.

Estimates Of Calcium Balance For Laying Birds Maintained In Different Environments

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Various hypotheses have been presented in attempts to explain why egg shell quality deteriorates when laying birds are exposed to heat stress. Carbonic anhydrase inhibition, calcium loss by diuresis, decline in appetite, and impaired calcium absorption have all been investigated. It is probable that these and other factors may be involved.

Single comb W.L. pullets were maintained under identical management conditions in each of three environmental chambers maintained constantly at 60°, 75°, and 90° ± 2° F. All birds received 14 hours of light and equivalent humidity and ventilation. Periodically experimental birds were replaced by others that were gradually acclimated before use in the study.

Balance studies employing Ca^{47} or Ca^{45} were conducted both with entire and colostomized birds. Both the appetite and amount of dietary calcium retained by the birds decreased as environmental temperature increased. Results indicate that when the environmental temperature exceeds 85° F. high producing layers enter a negative calcium balance, irrespective of calcium content of the diet.

Calcium And Phosphorus Requirements Of Laying Coturnix Quail

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To determine calcium and phosphorus requirements for laying coturnix quail, two experiments have been conducted using Auburn 571 strain birds. In the first experiment 16 birds of each sex were allocated at random to each of six treatments. The birds were housed in small laying cages and one male and one female were caged together. All birds were from the same hatch and were raised as one group until 28 days old. In the second experiment there were 16 colonies each containing 18 females and 6 males.

These birds were selected at random from the same hatch. Two replications of eight treatments were randomly alloted to the 16 groups.

In both experiments all diets were in crumble form and contained 750 Cal/lb P.E. and 28% crude protein. Unless otherwise stated all diets contained 1.25% total phosphorus, 625 ICU/lb vitamin D and 6,000 IU/lb vitamin A. Diets used in the first treatments of experiment 1 contained 2, 3, 4, and 5% calcium, respectively, whereas birds in treatment 5 were fed a diet containing 3% calcium plus 600 extra ICU/lb vitamin D. The diet fed birds in treatment 6 contained 2.6% calcium and 1.65% total phosphorus.

In the second experiment the first four treatments received 2.5, 3.0, 4.0, and 5.0% calcium. Birds in treatments 5-8 were at the same calcium levels, respectively, and 1.75% total phosphorus.

In both experiments which lasted through a 6-month-laying period, the birds receiving 4% calcium laid significantly more eggs ($P<.01$). These birds reached sexual maturity earlier ($P<.05$), although maturity was deliberately delayed by exposing the birds to less than a 14-hour day. The superiority in egg production was evident throughout the laying period. The additional vitamin D and phosphorus reduced egg production, although the difference was insignificant for the phosphorus. There were no significant differences in the results between treatments of either experiment for fertility, hatchability, mortality, egg weight, shell thickness, dry shell weight, and specific gravity.

A dietary level of 4% calcium and 1.25% total phosphorus, therefore, significantly improved egg production but did not effect egg size and shell quality.

An Approach To Evaluating Environmental Factors On The Development Of Peanut Leafspot

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Early peanut leafspot, caused by *Cercospora arachidicola* Hori, is the most important disease of peanuts in Alabama and Georgia; it may reduce yields as much as 20 to 30% when control measures are not practiced. Little fundamental research has been directed toward definition of environmental factors related to epiphytology of the disease under field conditions.

Glass microscope slides with a vaseline film on one surface, were exposed for half-week periods in weather-vane type spore traps at six predetermined locations in a peanut field to determine dissemination rate and density of *Cercospora* spores. All slides were examined microscopically and number of trapped spores recorded. Infectivity was determined by exposing *Cercospora*-free potted peanut plants simultaneously with the slides. Following field exposure, the potted plants were incubated for 72 hr. in a greenhouse moist chamber and observed for *Cercospora* leafspot symptoms. Leaf samples were collected bi-monthly from plants, and four plants were examined bi-weekly growing under field conditions to determine the average number of lesions per leaf as an estimate of relative infection. Maximum and minimum air temperature, relative humidity, and rainfall were recorded and correlated with leafspot data.

Data obtained in a 2-year period were analyzed by multiple correlation and regression analysis to determine the relationship between inoculum levels, incidence of infection to rainfall, relative humidity, temperature, and time. Data from the following variables were analyzed: rainfall in inches; maximum, minimum and average per cent relative humidity; maximum, minimum, and average temperature in degrees Fahrenheit; minimum relative humidity (lowest in the period); maximum temperature (highest in the period); minimum temperature (lowest in the period); and bi-weekly plant exposure periods.

During the first year inoculum level was related in descending order of importance to (1) bi-weekly plant exposure period, (2) maximum temperatures, and (3) rainfall, while incidence of infection was related only to minimum temperature. During the second year inoculum level was related to (1) rainfall, (2) minimum relative humidities, and (3) maximum temperatures, while incidence of infection was related to (1) bi-weekly plant exposure periods and (2) minimum relative humidities. With most fungi rainfall, maximum temperatures, and length of minimum relative humidity periods are the most critical factors in incidence of plant infection. Apparently *C. arachidicola* follows essentially this pattern as regards infectivity on peanut plants and its relationship to ecological conditions in the environment.

Reactions Of The Domestic Fowl To Various Air Velocities In A Wind Tunnel

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A review of the various types of air-measuring devices that could be used to measure air movement around poultry indicated that a venturi-type wind tunnel would most accurately produce and measure air velocities between 30 and 300 meters per minute. The tunnel was constructed to hold one or more birds. The projected area of the birds in the tunnel's test section was determined by photographing the birds against a grid background.

Air velocity in vicinity of the birds was determined from mass flow rate in the venturi throat and from the free air space surrounding the birds. The mass flow rate was determined by measuring pressure distance across the venturi and by using a Pilot-static tube in the venturi throat. Both methods provided an accurate and quick means for calculating mass air flow.

To date the wind tunnel has been used to determine the reactions of conditioned and unconditioned SCWL pullets exposed to various air velocities at either 16, 21, or 27° C. The tunnel has also been used to investigate impedance of the air flow by various types and sizes of wire mesh and poultry house curtain materials.

An Apparent Sex-Ratio Factor In *Tribolium castaneum* (Herbst)

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While studying the linkage relationships between red eye (r), tarsus irregular (ti), and spotted (sp), a cross of a r ti +/++ sp dam to a foundation sire yielded 28 F_1 progeny all of which were females. These 28 female progeny were divided into three groups: 12 F_1 females were mated with their sire and collectively produced 632 progeny, all females. Ten F_1 females were pair-mated to new foundation males and these collectively produced 479 female and 533 male progeny. The remaining 6 F_1 females were pair-mated to *ti* males and these jointly produced 209 females and 239 males.

The originally obtained all-female F_1 progeny was, therefore, directly related to the original sire. Studies were initiated to determine if male zygotes failing to eclose were being produced by dams mated to this sire, or if the disturbed sex-ratio was occurring prior to fertilization. Twenty four-hour egg collections were made from this sire mated with: (1) F_1 females, (2) new foundation females, and (3) "F_2" females (from the mating F_1 females X new foundation males). Of the eggs obtained from these three sources, means of 18.8%, 25.8%, and 22.9% respectively hatched. All hatched eggs developed into female beetles. A control cross produced 85% egg hatch yielding female and male adults equally. The original sire not only produced a lack of male offspring but a reduced percentage of female progeny.

A variety of crosses were undertaken to get the original sire to transmit this aberrant sex-ratio factor to its progeny to permit further genetic analysis. Matings to ascertain if the original sire had lost some of its genetic material through deletions were undertaken. Recessive marker genes on all chromosomes were employed in this search. However, the sire died before his complete genetic constitution could be elucidated.

The Kinetics Of The Response Of Cultured L1210 Leukemic Cells To 1,3-bis(2-Chloroethyl)-1-Nitrosourea (BCNU) And Nitrogen Mustard (HN2)

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Cultures of L1210 leukemia cells were grown *in vitro* and maintained in logarithmic growth phase. The actively growing cells were exposed to selected drug concentrations for varying periods of time and the number of cells surviving drug treatment was estimated by an animal bioassay method for cell viability. At concentrations of 4.0 and 8.0μ g of BCNU/ml the rate of cell kill followed first order kinetics with cell population half-lives, respectively, of 8.4 and 2.4 minutes. Cell kill with HN2 at a concentration of 1.0 μ g/ml, also followed first order kinetics with a cell population half-life of 20.3 minutes.

The concentration-time relationship for BCNU was 1.6 and for HN2 1.0. The cultured L1210 cells were more sensitive to NH2 than to BCNU on a molar basis. Supported by Contract No. PH43-65-594 with the National Cancer Institute.

Chemistry

A Chemistry Placement Test

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The quality of chemistry instruction, where it is taught at all in Alabama high schools, varies from poor to excellent. Consequently, students in freshman chemistry at the University of Alabama have

had widely divergent preparations for university-level chemistry courses.

In order to place students in freshman chemistry in courses for which they have adequate background and at the same time provide challenging situations for well-prepared students, a series of three one-semester courses in general chemistry has been established. A chemistry placement test has been constructed to use as a basis for placing entering freshmen in the chemistry courses for which their previous training has prepared them.

Students who come to the University with excellent training in high school chemistry may complete "freshman" chemistry in one semester. Many students require two semesters to complete freshman chemistry, while other students whose curricula require more "practical chemistry," and who elect chemistry to satisfy general education requirements, take a one-semester course in general chemistry and a one-semester course in organic chemistry. All students who plan to take the student chemistry courses beyond the freshman level must complete the highest level freshman course.

Statistics data on approximately 5000 students indicate that the predictive validity of the test is high. Interestingly, the test has predictive value in other areas of physical science as well as in areas which have no apparent relationship to the physical sciences.

Heat Capacities Of Sodium Bromate, Sodium Bromide, Sodium Iodate And Sodium Iodide At High Temperature

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The heat capacities of $NaBrO_3$, NaBr, $NaIO_3$ and NaI were determined at high temperatures. A copper block calorimeter was used. The calorimeter was calibrated by electrical methods and checked by means of a Bureau of Standards sample of aluminum oxide. The heat content equations for the compounds were calculated to fit the conditions:

$$H_T - H_{298.16} = a + bT + cT^2 + dT^{-1}$$
$$a + bT + cT^2 + dT^{-1} = O \text{ at } 298.16\ ^\circ K$$

The values of the constants in the equations were calculated by the method of least squares, using the UNIVAC solid state 80 computer.

The Identification Of The Ultraviolet Spectra Of The Chromium (VI) Complexes Of Several Diesters Of Phenylphosphonic Acid

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When a standard solution of $K_2Cr_2O_7$ in 1 N HCl is added to a 5% v/v solution of di-sec-butyl phenylphosphonate (DSBPP) or di-n-butyl phenylphosphonate (DBPP) in kerosene, an orange layer separates between the aqueous and the organic layers. This layer is assumed to be essentially pure di-sec-butyl (or di-n-butyl) phenylphosphonate chromium (VI) complex. When a saturated solution of $K_2Cr_2O_7$ in 1 N HCl is treated with di-octyl phenylphosphonate (DOPP), however, no third layer forms.

Spectral data in the ultraviolet have been collected on the di-sec-butyl phenylphosphonate and di-n-butyl phenylphosphonate chromium (VI) complexes and on the organic layer from extraction of chromium with di-octyl phenylphosphonate, and an attempt has been made to interpret this data.

The Relation Of Models And Understanding In Science

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Common use of the word understand seems to mean "to be familiar and predictable." Several demonstrations were presented and by relating what was seen to something familiar to each member of the audience, the puzzles became "understandable." Process of understanding in science usually involves construction of "models" to account for the facts. Models may be verbal, conceptual, mathematical or actual three dimensional constructions. Two analogies were presented on how we receive information on which to base our model construction. One was the general well behind the lines gets his information from five telegraph lines and by use of map and wooden blocks makes a model to help visualize what might be taking place on the battle field. This corresponds to our five senses. The other analogy was the famous "black box." Models of what is in the sealed box are constructed based on information gained by tilting and shaking the box. Three different models were constructed which accounted equally well for facts obtained. The object was removed from the box to illustrate how new discoveries come as a complete shock or surprise. It is legitimate for a scientists to say he "understood last week" but does not understand this week because the model he was using was unable to account for the new discovered fact. A simple model to account for the "plastic with a memory" was constructed to illustrate how understanding is attained here. The same principles were used to construct a model for "forgiveness" using the bond approach. Belief that the models we construct are eye witness accounts or the actual realities leads to creation of "graven images" and the person becomes "idolatrous." Models are never certain and are always subject to revision. Each new model includes successful parts of old models nicely illustrated by looking at models of atoms from JJ Thompson to present quantum mechanical models. Model at best is "small imitation of the real thing." Confusion of models with the real thing is still somewhat common in science but even worse in theology, social sciences etc. Models are postulated not deduced. A good model is a way of arriving at "instant truth." Scientific models must be tested against facts, observations and experiments. The mathematician if he is pure, makes his constructions without regard to reality and is always hoping to make a construction which will not correspond to any form of reality. Most mathematical constructions sooner or later become models for some portion of reality. Some classical procedure for stimulating new ideas or models were discussed. Included were (1) Stating problem in general terms. (2) Take any useful model and invert one of the postulate. (3) Assume one cause. For example assume only way to make an electric current flow through a metallie conductor is by a changing magnetic field near it. Then show that thermoeleetricity, galvanic electricity, piezo electricity, photoelectricity etc. are in fact result of changing magnetic fields.

Cryoscopic Behavior Of Selected Solutes In The Molten Alkai Nitrates. II.

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Freezing point measurements were made on dilute solutions of $NiSO_4$, $CuCl_2$, $ZnCl_2$, $ZnSO_4$ and $CdCl_2$ in molten lithium nitrate and in mixtures of molten lithium nitrate and sodium sulfate or sodium chloride. Freezing point measurements were also made on dilute solutions of $CoCl_2$, $CoSO_4$, $NiCl_2$, $NiSO_4$, $CuCl_2$, $CuSO_4$, $ZnSO_4$, $CdSO_4$, and $PbSO_4$ in molten sodium nitrate and in mixtures of molten sodium nitrate and sodium sulfate or sodium chloride. Finally, freezing point measurements were made on dilute solutions of $CoSO_4$, $NiSO_4$ and $PbSO_4$ in molten potassium nitrate. It was found in most of the systems studied that these substrates were incompletely dissociated and stability constants were calculated for these substances, using the method of Blander (J. Am. Chem. Soc., 84, 1529 (1962)). The values of the stability constants thus obtained were compared with other values previously obtained in the same solvent systems. This work was supported by a grant from the U.S. Atomic Energy Commission.

Cryoscopic Determination Of Stability Constants In The Sodium Nitrate-Potassium Nitrate Eutectic

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Cryoscopic methods have been used to study the formation of Copper(II), Cobalt(II), Cadmium-(II), and Zinc(II) complexes with chloride and sulfate ions in solutions to 0.1 molal, using the Sodium Nitrate-Potassium Nitrate eutectic as a solvent system.

The freezing point depression of the eutectic melt with the addition of pure metal chlorides or sulfates and the addition of the metal chlorides and sulfates in the presence of added common anions was measured. Formation constants were calculated for metal chloride and sulfate complexes. This research was supported by a grant from the Atomic Energy Commission.

Geology

Lunar Surface Mining: Problems And Possibilities

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In this paper the reasons for exploring for and exploiting lunar resources and the circumstances that may render exploitation economic, are briefly reviewed. Reviewed briefly, also, are the theories regarding the two geological forces believed to be chiefly responsible for lunar surface features and the possible lunar thermal histories.

Possible modes of occurrence of deposits of free water are discussed, based upon both principal theories of lunar geology. Most of these are models taken from the literature, but a few may be new. The same thing is done for possible occurrences of hydrous rock minerals.

Surface mining problems are discussed from the standpoint of probable (a) lunar surface environmental conditions and (b) lunar surface layer structure (first 100 km particularly). The models possibly amenable to surface mining are selected and the problems involved and the likely yields, are discussed.

Both surface mining proper and remote control mining from the surface are considered with most attention given to the former.

Will The Water Resources Research Institute Finance Your Next Research

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The Water Resources Research Institute was established at Auburn University June 3, 1963, to stimulate, sponsor, provide for, and supplement present programs for the conduct of research, investigations, experiments, and the training of scientists in the fields of water and of resources which affect water. The program is developed having due regard to the varying conditions and needs of the State and region, to water research projects being conducted by agencies of the Federal and State Governments, the agricultural experiment stations, and others. The Institute's program is operated as a cooperative Federal-State partnership with the Department of the Interior's Office of Water Resources Research under the Water Resources Research Act of 1964 (PL 88-379). Present sources of funds are the Water Resources Research Institute, other Auburn University monies, the University of Alabama, the Geological Survey of Alabama, and the Office of Water Resources Research.

The FY 1966 budget of $168,000 includes support of eleven water resources research projects involving two universities and the Geological Survey. The proposed FY 1967 budget of $331,000 will afford support of thirteen projects — four of which are new — involving two universities and the Geological Survey. As a staff member of any college or university, your interests and capabilities in water resources research may qualify for support from the Institute.

Physics And Mathematics

Magnetic Resonance Studies Of Electron Spin-Lattice Relaxation

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A large body of data has been reported in the past several years on the relaxation processes which tend to maintain paramagnetic ions in thermal equilibrium with their host lattice. The simplest treatment of paramagnetic relaxation assumes two systems of spin and lattice oscillators, which are physically interspersed but weakly coupled with each other. The coupling within each system is assumed to be strong, so that each is in a state of internal thermodynamic equilibrium characterized by a temperature, and relaxation is depicted as a kind of heat conduction whereby energy given initially to the spin system becomes transferred to the crystal lattice. The exchange of energy between the spin system and the lattice vibrations, or phonons, of the lattice can be brought about by at least three basic processes: direct resonance processes in which the frequencies of the lattice phonons are identical with the transition frequencies between the energy levels of the spin system, Orbach processes in which two phonons participate in a two-step relaxation process involving only low-lying excited states, and Raman processes in which the spin reversal is accompanied by the creation of one phonon and the destruction of another in such a manner that the difference in energy of the two phonons is equal to the change in the spin energy. Studies of these and related processes are being made by pulse resonance techniques at approximately 9 Gc/s as a function of magnetic field, cryogenic temperature, crystal orientation, etc. The relaxation characteristics that have been observed in a number of crystals containing both iron-group and rare-earth impurities will be revived.

The CUPM Birmingham Conference

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The Panel on Teacher Training of the Committee on the Undergraduate Program in Mathematics (CUPM) of the Mathematical Association of America held a regional conference in Birmingham December 10-11, 1965. Representatives from colleges and universi-

ties in Alabama, from some of the school systems in the state, from the State Department of Education and members of the Panel on Teacher Training were the participants. The conference discussed course outlines in mathematics for the training of elementary school teachers.

The following are the principal resolutions formulated by the conference. College-bound students should be advised to take at least two years of college preparatory mathematics, including algebra and geometry in the case of prospective elementary teachers. These should also be requirements for admission to the elementary education program. College mathematics departments should offer courses designed for elementary teachers and work towards the four course sequence recommended by CUPM. This sequence consists of two courses in the structure of the real number system, one course in algebra and one course in geometry. The Alabama State Department of Education should include mathematics in the certification requirements for elementary teachers.

Electron Microscope Study Of Destructive Breakdown Of Vacuum Deposited Thin Film SiO Capacitors

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Metal-SiO-metal capacitors, fabricated by vacuum deposition techniques, have been subjected to breakdown tests in an electron microscope in an effort to relate capacitor breakdown, deposition conditions and capacitor structure. Two substrates have been used: glass microscope slides and similar slides coated with a thin layer of vacuum-deposited carbon. Capacitors were stripped from the carbon-coated slides and tested for breakdown in the electron microscope. The electron beam, when adjusted near cross-over, promoted the occurrence of breakdowns in the field of view in preference to other parts of the capacitor not illuminated so strongly. Both dc and pulse voltages were used to generate breakdowns. These breakdowns, which occur in electric fields of about one million volts per centimeter, are characterized by a sudden decrease (or pulse) in the voltage across the capacitor. Breakdowns observed in the stripped capacitors in the electron microscope are similar to those in capacitors on glass substrates both in appearance and in electrical behavior. Work supported by the National Aeronautics and Space Administration.

Spectral Information And Integral Equations

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A problem of universal interest is the solution of the integral equation of the first kind,

$$n(x) = \int_{\alpha}^{\beta} N(x')G(x,x',)dx',$$

insofar as this integral represents the response of an experimental apparatus to the measurement of a theoretical, or ideal, distribution function N(x′). For many systems this is indeed the case, and the apparatus or resolution function G(x,x′) distorts or smears the ideal distribution, N(x′), into the observed distribution n (x).

In the present work the problem of unfolding the function N(x′) is solved, and the two methods for accomplishing this are presented. These techniques are based on numerical solutions of the integral equation. The first technique employs the experimental data in a last squares criterion, and the second technique is a modified least squares approach using a priori information to limit the appearance of unrealistic oscillations in the solution. These techniques have been applied to various types of distributions including experimental data containing statistical fluctuations with very good results.

Extinction Efficiency Of Spinach Chloroplasts

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Absolute extinction efficiencies of spinach chloroplasts were measured in this experiment. The method used is described by Latimer and Eubanks. This determination of extinction efficiencies requires the measurement of spectral curves of transmission for the suspension, the concentration of particles in the suspension, and the average particles dimensions. The extinction efficiencies, which vary with wavelength, were found to be of the order of 0.2 in the red spectral region. Values of approximately 0.3 were reported by Latimer and of 0.3-0.7 by Bryant for this same spectral region.

A New Lattice Quasiparticle In The Second Quantization Formalism—Concept And Application

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Quantization of the classical electromagnetic field describable by the Maxwell's equations has led to the concept of photons. Their reality has been demonstrated many times since Albert Einstein explained the photoelectric effect by equating E = hν. Some twenty years later, Igor Tamm proposed, in analogy to the quasiparticle of the radiation field, the name of phonon for the quasiparticle resulting from the quantization of lattice vibrations. The general validity of the phonon concept has been proven in many experiments in which vibrational states of the lattice are involved. Our recent experimental work made use of the optical analog of the nuclear Mössbauer effect to measure the resonant absorption of the photon in an electron-phonon system. To calculate the no-phonon transition probability, we have employed the method of moments and ordinary quantum mechanics. However, it was convenient to introduce some aspects of the formalism of the second quantization in calculating the band shape of one phonon induced spectrum in which the absorbed photon imparts energy to the optic electron as well as to the lattice. A much more elegant theoretical treatment of the line shape problem can be devised by employing the temperature-dependent double-time Green's function technique of Bogoliubov and Tyablikov. Such an attempt has been made previously by Nishikawa and Barrie. However, in setting up their basic Hamiltonian for an interacting electron-phonon system in the second-quantized form, the previous authors used the conventional phonon raising and lowering operators constructed from a linear combination of the canonically-conjugated position and momentum observables of the harmonic oscillator. The interaction term of the electron-phonon Hamiltonian using these raising and lowering operators leads to the non-conservation of the usual quasiparticles. Consequently, the conventional quasiparticle number operator is not a constant of motion and therefore does not commute with the Hamiltonian. This non-commutation of the number operator and the total Hamiltonian raises computational problems which can be circumvented only by making certain approximations of dubious validity. Using the second-quantization procedures applied earlier for the boson field, a new lattice quasiparticle concept for the field of crystalline lattice has been worked out in which the operator for the total number of our new lattice quasiparticles commutes with the Hamiltonian even in a strongly interacting system. This is accomplished by representing the lattice as a set of operator fields, one for each vibrational coordinate. As a result, a canonical ensemble of quasiparticles (each having a set of eigenstates and eigenvalues) is obtained. In our formalism, there exists an isomorphic correspondence of quasiparticles and vibrational modes of the lattice which satisfies the physical requirements of the problem. Our formalism is different from the conventional approach in which each vibrational mode is described as a constituent of a grand canonical ensemble containing conventional lattice quasiparticles (phonons), the number of which is not conserved. In this paper, the relation between those two alternate approaches is outlined, and the relative merits of the new formalism pointed out. Green's functions constructed using the new quasiparticle concept lend themselves to the calculation of line shapes of an interacting electron-phonon system without the previously required approximations. Specifically, this calculation has been carried out for the case of one electron trapped in a lattice defect and has given results in a good agreement with experimental measurements.

Piezospectroscopy Of No-Phonon Transitions In Defect Solids

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The discovery of stimulation of optical radiation from excited electronic states in defect solids has led to a renaisance of high-resolution spectroscopy in solid state physics. In particular, interest has arisen how the spectrum of an electronic transition is affected by static and dynamic stresses imposed upon the crystalline lattice surrounding the imperfection. The hydrostatic pressure technique pioneered by Bridgman has shown that generally a shift of the spectral line under pressure occurs. However, in the hydrostatic pressure experiments, the crystal is compressed isotropically and thus only a limited amount of physical information can be extracted from the data if either the crystalline lattice or the defect center displays anistropy. Using symmetry properties of point groups, Kaplyanski has shown recently that several important parameters of defect centers such as their spatial orientation, their nature and their complexity can be deduced by measuring the spectral shift and line splitting observable under an uniaxial stress applied consecutively along different crystalline axes. As a model substance for our investigation, centers induced by neutron irradiation of single MgO crystals (face centered cubic structure) have been chosen. Many of these color centers exhibit no-phonon transitions of the in-the-defect trapped optic electrons beside the broad bands usually associated with such centers. In particular, the uniaxial stress induced shift and splitting of the 27,650 cm^{-1} and 9,570 cm^{-1} no-phonon lines at liquid nitrogen and liquid helium temperatures have been determined using a cryogenic uniaxial piezospectroscopic cell of our design. This cell allows the application of a continuously variable stress up to several kilobars magnitude and can be attached to commercially available research dewars provided with optical access windows. Data were gathered for stresses applied in (010), (110) and (111) crystallographic directions with monochromatic light polarized either perpendicularly or in parallel to the direction of the stress. The results indicate that both of the centers are defect aggregates.

Social Sciences And Anthropology

A Comparison Of Kaolin Pipe Fragments From Two Upper Creek Sites

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The dating of historic archaeological sites by a procedure of measuring and comparing kaolin pipe stem hole diameters has aroused serious consideration and comment since it was first proposed in 1954 by J. C. Harrington. Lewis Binford in 1961 developed a mathematical formula for Harrington's histogram and provided another aspect of this dating process. In an application of these procedures, the sites of Big Tulsa or Talassee and Tukabahchee were utilized for this paper. These sites are in close proximity and were occupied during approximately the same time span. Measurements of pipe fragments were made on material collected from the surface of both sites from 1952 to 1962. This collection contained 81 pipe stems from Big Tulsa and 241 from Tukabahchee. Analyses of this material place both sites within Harrington's time period of 1710 to 1750. Mean dates for each site as derived from Binford's formula are 1740 for Big Tulsa and 1744 for Tukabahchee. The attainment of these dates along with the general time period fits in well with the archaeological and historical reconstruction of the Upper Creeks in central Alabama.

A Preliminary Report On The Burial Practices At The "Sand Island" Sites, Alabama

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During the summer of 1965, a University of Alabama field crew investigated two sites, Wx^{v}12 and Wx^{v}10 on the east bank of the Alabama River in Wilcox County, Alabama in a small area locally known as "Sand Island." In the course of excavations a total of several burials was encountered at the two sites – three urn internments, one extended burial, and one multiple burial of three skulls.

Wx^{v}12 is the larger of the sites, and a tentative analysis of the ceramics indicated a component related to the Fort Walton complex of Florida. Some European influence was indicated by trade material associated with a burial. Three large shell tempered urns were encountered, each containing a single infant. Two of the urns possessed covers of varying form. The form and worn condition of the vessels and the anatomical position of the burials would tend to indicate placement of the body in an intact state in a generally well used utility ware vessel.

An extended adolescent burial beneath a fragmentary clay house floor had associations of three shell artifacts and 20 European glass trade beads.

Wx^{v}10, one mile to the southwest of Wx^{v}12, appears to have been occupied at an earlier period and for a longer time, possibly early Woodland to early Mississippian. A single multiple burial consisting of three skulls was located at the bottom of the midden in an indistinct pit intruding into underlying sterile sand. The skulls were arranged haphazardly in the pit as if they had been merely tossed in. There was evidence of pre-mortem skull fractures on two skulls and a shattered mandible on the third.

Medical Sciences

Crawford Williamson Long

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Crawford Williamson Long was born on November 1, 1815 at Danielsville, Madison County, Georgia.

Samuel Long, Crawford's grandfather, came to America in 1762 and settled in the Carlisle area of Pennsylvania. Samuel and his son, James, moved to the south in 1788 and settled in Madison

County, Georgia. James, the father of Crawford, was nine years old when they came to Georgia. James Long became a prosperous business man. He owned the first store in Danielsville, helped establish the academy and was postmaster of the village. Young Crawford attended the academy before he entered Franklin College, now the University of Georgia. He graduated in 1835 with the degree, Master of Arts. The next year was spent as head of the academy. However, he began to read medicine the next year with Dr. George R. Grant of Jefferson, Georgia.

In 1837, Crawford entered the Medical School of the University of Pennsylvania. He received the M.D. degree in 1839 and after eighteen months of intern work in New York hospitals, he bought the office of his old preceptor, Dr. Grant and soon had an extensive practice.

It was customary in those days of social gatherings to inhale nitrous oxide or "laughing gas" for the amusement afforded by the peculiar behavior of the one inhaling the gas. In December, 1841, Dr. Long, not having any nitrous oxide, substituted sulphuric ether and the results were so pleasing that "ether frolics" became quite fashionable. Dr. Long noticed that some of the young men, while under the influence of ether, received falls and blows which should have caused pain to a person not inhaling the anesthetic. This led Dr. Long to believe that ether could be used in surgical operations.

On March 30, 1842, James Venable was given ether and Dr. Long removed two cysts from his neck. Mr. Venable did not experience pain during the operation.

Dr. Crawford Long and his brother, Dr. H. R. J. Long opened a drug store in Athens in 1851. It was the largest drug store in southeastern Georgia and the advertisement which appeared in the Southern Banner was in considerable detail and listed medicine, drugs, toilet articles, paints, oils, glass, etcetera.

Dr. Long used the ether in obstetrics and a few operations but his associates discouraged its use in favor of the new fad, mesmerism. In the meantime, others did use ether and attempted to establish the fact that they were the ones who should receive the credit for its discovery as an anesthetic.

Dr. W. T. G. Morton, a dentist, Dr. Charles T. Jackson, an analytical chemist and Dr. Horace Wells, a dentist, all attempted to establish credit for discovering the anesthetic properties of ether. In September, 1846, Dr. Jackson had given Dr. Morton some ether to allay the pain of a patient. They applied for a patent. Then in 1849, Dr. Morton and Dr. Wells petitioned the U.S. Congress for a reward for the use of ether. Dr. Jackson proposed to Dr. Long that they lay their claims before Congress that Jackson would claim discovery and that Long would claim the first practical use. Dr. Long refused to agree to any such plan. All of the plans made by Jackson, Morton and Wells failed. Jackson lost his mind and died in an insane hospital. Wells also lost his mind and committed suicide. Morton was practically a pauper when he died.

Many memorials have been established in honor of Dr. Long and his discovery of the anesthetic properties of ether: (1) Crawford W. Long Museum, Jefferson, Georgia; (2) Statute of Dr. Long in the National Hall of Fame in Washington, D.C.; (3) A bust of Dr. Long in the state capitol, Hall of Fame, Atlanta; (4) a stone monument was erected to Long in Danielsville; (5) a bronze bust of Dr. Long is in the University of Edinburgh, Scotland, etc.

William Elias Brownlee Davis:—Surgeon—Teacher—Organizer

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William Elias Brownlee Davis represented the fourth generation of physicians in his family. His father, Dr. Elias Davis, was killed while commanding sharpshooters at Petersburg, Va. William E. B. Davis, a posthumous child, was born on November 25, 1863, at Trussville, Jefferson County, Alabama, eight years before Birmingham was incorporated on December 19, 1871.

Young William's brother, J. D. S. Davis, graduated from the Medical College of Georgia in 1879. William attended the University of Alabama before he studied medicine at Vanderbilt University, the University of Louisville and the Bellevue Hospital Medical College in New York City where he received the M.D. degree in 1884. He joined his brother in practice in Birmingham and entered upon a very fruitful career which lasted almost twenty years.

The Davis brothers established *The Alabama Medical and Surgical Journal* which first appeared in July, 1886. Dr. Jerome Cochran favored a board of medical examiners for each county and the Davis brothers argued editorially for a single state board. In the Journal, they also urged that only medical graduates be examined for license. At the state society meeting in March, 1887, Cochran's views prevailed and, as a result, the new Journal failed to appear after the May, 1887 issue.

However, the Journal office was used in November, 1886 for a meeting of a small group to consider formation of a state surgical and gynecological society. The organizational meeting was held the next month and William was elected the secretary. This organization only served to stimulate William to organize a broader organization, the Southern Surgical and Gynecological Association which held its organization meeting on October 12, 1887 in the Y.M.C.A. Hall, Birmingham, and he was elected secretary.

The Association held its first meeting in December, 1888 and William was elected president of the Association in 1901.

Dr. W. E. B. Davis was active in many medical organizations. He was elected vice president of the American Medical Association in 1892. He was president of the American Association of Obstetricians and Gynecologists in 1900-1901.

The Davis brothers were among the nine trustees and incorporators when the Birmingham Medical College was established in 1894. Dr. W. E. B. Davis was appointed Professor of Gynecology and Abdominal Surgery and he continued in that position until his death.

The Davis brothers operated a private infirmary for diseases of women and surgical cases for about ten years, 1893-1903. It was the first hospital in the new city of Birmingham.

Dr. Davis was a baptist and belonged to the Knights of Pythias.

Dr. W. E. B. Davis was described as tall, with clear-cut, angular features, brilliant, a good speaker and a man who was peculiarly gifted to organize medical societies and associations. While in his fortieth year, he was killed at a railroad crossing in Birmingham on February 24, 1903.

William McFarland Boling—Physician—Teacher

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William McFarland Boling was born at Elicott's Mills, Baltimore County, Maryland on July 14, 1811. His father died soon after his birth and his mother moved to Greensburg, Penn. When William was 18 years old he began to read medicine with Dr. S. P. Brown. After two and a half years he enrolled at Jefferson Medical College on October 2, 1835. Soon after the close of the session, he set out for Alabama in quest of a location to begin the practice of medicine. He settled in Coosada, Autauga County, near Montgomery. He practiced with much success until the fall of 1837 when he returned for a second course of lectures at Jefferson Medical College. After graduation on March 8, 1838, he returned to Alabama and settled in Montgomery where he continued to reside until his death except for two courses of lectures that he gave. In

1848, he was invited to take the chair of Materia Medica in Memphis Medical College but resigned after one session. In 1849, he was called to the chair of Obstetrics at the Medical Department of Transylvania University, Kentucky, and, as before, he resigned after one session and returned to his home in Montgomery.

Two of Dr. Boling's colleagues in Montgomery became president of the American Medical Association, Dr. W. O. Baldwin in 1868 and Dr. J. Marion Sims in 1876. Dr. Boling and Dr. Baldwin formed a partnership in 1848 which lasted for four years.

Dr. Boling was one of the rare physicians who published his findings in the most respected journals. The titles of his papers point up the fact that he was a well rounded and educated person. The following list of titles impresses one as to his broad experience: Cataract Operation; Use of Sulphate of Quinine in Continued Fever; Experiments with Phosphorous; Physical Sign of Pneumonia at the Apex of the Lungs; Injurious Effects of the Use of Antimony in Pneumonia; Ligature of the External Iliac for Aneurism; Remittant Fever; Mechanism and Management of Parturition in the Shoulder Presentation and Yellow Fever in Alabama.

Dr. Boling was quite active in the Medical Association of the State of Alabama. He was elected president of the Association in 1851. He was elected vice president of the American Medical Association in 1855 and was active for several years in committee work of the organization.

In the early 1850's, Dr. Boling became a paraplegic and although it was difficult for him, he continued to practice medicine until a few months before his death on March 4, 1859.

Dr. Boling was an Episcopalian, a Mason and an Odd Fellow. He married Mary Vincent of Autauga County on October 24, 1837. The Bolings had four children: Helen McFarland, Amelia Donne, William McFarland, and George.

Effect Of Long Term Androgen-Estrogen Therapy On Life Span Of The Female Rat

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We have previously found that certain patterns of steroid therapy can give statistically significant increase in life span and that other patterns reduce life span of the Norway rat. In the present investigation we have measured the effect on life span of continuous injection of two androgen-estrogen combinations begun at early middle age (434 days) and continued until all rats had died of natural causes. In both treated groups the androgen (methyltestosterone [MT]) and the estrogen (diethylstilbestrol [DES]) were injected subcutaneously every second day as a mixed microcrystalline suspension in physiological saline solution.

Group T-5 (10 females) received 0.75 mg. MT and 0.05 mg. DES per injection (a ratio of 15/1).

Group T-6 (10 females) received 0.75 mg. MT and 0.15 mg. DES per injection (a ratio of 5/1).

A total of 38 female rats with an average age of 434 days were divided among the above two treated groups and one uninjected control group. These rats were born and raised in our laboratory which has been maintained as a closed colony, derived from original Long-Evans stock, for 14 years. The controls (18 females) survived approximately one year (mean of 362 ± standard error of mean of 35 days) after the experiment was instituted. Both treated groups survived longer: T-5, 382±48 days; T-6, 419±59 days, but neither of these differs significantly from the controls (group comparison, t test). These steroids are frequently employed in geriatric practice in the ratios herein administered. Our data in the rat indicate that they are not deleterious to survival.

A routine autopsy was performed on all rats at natural death; all gross abnormalities were noted, and the probable cause of death was assigned. The probable cause of death was as follows:

Congestive heart failure: 78% of controls; 70% of Group T-5; 40% of Group T-6.

Tumor: 11% of controls; 10% of T-5 rats and 40% of T-6 rats.

Abscess: 5% of the controls; none of Group T-5; 20% of T-6 rats.

The remainder of the rats died of other or undetermined causes (occasionally an animal is not found soon enough after death to permit a meaningful post-mortem examination). Chi Square analysis of these data revealed no statistically significant alteration in organ abnormalities present at death.

In summary, the above described long-term (approximately one-half of the animal's life) treatments did not significantly alter either life span or cause of death.

Olfactory Fiber Projections From The Olfactory Formation

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In hamsters, discrete lesions were placed in the olfactory bulb, the accessory olfactory bulb, the accessory olfactory bulb and the anterior olfactory nucleus simultaneously or the whole olfactory bulb was removed at the retrobulbar region of one side. A survival time of from 7-21 days was allowed and, using the Nauta method, the brains were examined for degenerating axons.

Olfactory and accessory olfactory bulb lesions resulted in ipsilateral degeneration along the lateral olfactory tract. Terminal degeneration occurred in the piriform, the prepiriform and the periamygdaloid cortices, the intermediate and the lateral zones of the olfactory tubercle, the nucleus of the lateral olfactory tract, and the cortical and the medial nuclei of the amygdaloid complex. Degeneration was heavier in those with the accessory olfactory bulb lesion.

Degenerating fibers were present in the anterior commissure and in the heterolateral olfactory bulb in hamsters with lesions in the accessory olfactory bulb and anterior olfaetory nucleus or where the olfactory bulb was removed in one side. This was noted in addition to the terminal degeneration reported in olfactory bulb lesion. Terminal degeneration in the septal area occurred after the removal of the olfactory bulb. Supported by Grant No. NB 04295-03 from the United States Public Health Service.

Bacteria In Sewage-Borne Nematodes

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Because sewage-borne nematodes are suspected of being vectors of enteric diseases, a study was undertaken to develop a rapid scheme for screening the internal bacterial flora of nematodes for enteric pathogens.

The nematodes were extracted from sewage, externally sterilized, and ruptured to release the bacteria. The bacteria were isolated by membrane filter techniques and were purified.

The scheme consisted of simple, rapid tests which when interpreted collcetively differentiated among bacteria normally present in sewage. The isolation medium was MF-Endo's medium or bismuth sulfite agar; therefore, only bacteria capable of growth on these media were considered. Bacteria identified by this scheme were: *Aerobacter, Alcaligenes, E. coli, Klebsiella, Proteus,* Providence Group, *Pseudomonas,* and "Salmonella-like." Gram-negative bacilli constituted nearly 100 percent of the intestinal flora isolated on brain heart infusion.

This work emphasizes that nematodes may ingest human pathogens since related enteric genera have been found in the intestinal tract. This finding should be considered in the epidemiology of enteric diseases.

Binding Of DPNH To Glutamic Dehydrogenase: Effects Of Regulator Reagents

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One of the big problems to be solved in understanding biological processes is that of regulation. Since most biological reactions are catalyzed by enzymes, these catalysts are particularly interesting subjects for study when considering regulatory processes.

Glutamic dehydrogenase (L-glutamate-NAD-oxido reductase) has been studied as a model for regulation. This enzyme can exist in several different conformations which have different relative substrate specificities. The conformation which the enzyme will assume can be influenced by certain "regulator" reagents. For example, GTP, diethylstilbestrol, and Zn^{++} favor one conformation, while ADP, L-leucine, and high ionic strength favor another.

Diphosphopyridine nucleotide (DPNH), a co-factor for the enzyme reaction, is also involved in regulation because: (1) high concentrations of DPNH inhibit the enzyme; and (2) DPNH must be present before some of the regulator reagents exhibit their effects. It therefore became important to study DPNH binding to the enzyme to determine: (1) The number of sites on each enzyme chain and whether all sites are identical; (2) whether all conformations and polymeric forms of the enzyme have the same number of sites; and (3) whether regulatory reagents affect binding.

Using equilibrium dialysis, binding of DPNH to the enzyme was studied directly using a wide range of DPNH concentrations. These experiments were repeated in the presence of ADP, L-leucine, high ionic strength, GTP, diethylstilbestrol, and Zn^{++} to determine the effects of these regulatory reagents. Binding was also examined both at high enzyme concentration where aggregation occurs, and at low concentrations where the enzyme is disaggregated.

Results showed that the enzyme has one binding site for each protein chain comprising the polymeric form and this number is not changed by "regulator" molecules, or by disaggregation on enzyme dilution. However, GTP, diethylstilbestrol, and Zn^{++} increase binding strength while ADP, L-leucine and high ionic strength decrease binding strength. Thus these "regulator" molecules must act in part by changing the performance of the binding sites for DPNH.

A Bacteriophage For Arthrobacter Globiformis

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A bacteriophage for *Arthrobacter globiformis* ATCC 8010 was isolated from soil and has been purified by the conventional methods of picking, cultivation on the host bacterium, filtration, and plating on the host. The phage was virulent and specific for the host strain but resistant bacterial colonies appeared if incubation of plates was continued beyond 24 hours. Old coccoid cells, *i.e.* after about 20 hours in a broth culture grown on a mechanical shaker, and younger myceloid forms when they were fragmenting into cocci adsorbed the phage particles and supported phage multiplication and plaque formation. However, younger true mycelial forms failed to support plaque formation. These results suggested that the receptor sites for adsorption of the phage or the metabolic age of the cells differ with the morphological form in a manner reversed from the usual assumption that viruses develop only in young cells. Bacteria-free phage preparations were not consistently obtained when a millipore filter of 0.2 micron pore size was used and established the size of the small coccoid old cells as smaller than 0.2 micron. Furthermore these cells multiplied upon 5 C. storage of the phage preparations.

Enteric Bacteria Population Studies Of Some Sewage-Borne Nematodes

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Studies of nematodal ingestion of sewage-borne bacteria were performed in three sewage treatment plants.

Determinations were performed upon intranematodal bacteria extracted from sewage-borne nematodes. The nemas were isolated from sewages collected at the plant influents and at the effluent of each unit process in the primary, trickling filter, and activated sludge treatment plants. Using the membrane filter technique; total bacteria, enterococci, coliforms, and bacteria which would grow on bismuth sulfite agar were enumerated. The latter organisms are referred to as the "Bismuth Sulfite Group."

Nematodes in the trickling filter treatment process were found to ingest a large number of enteric bacteria in the final sedimentation basin. The primary treatment and activated sludge processes examined are apparently of relatively less public health significance because nemas in these processes are unable to ingest as many enteric bacteria per nematode discharged.

On an average day a trickling filter plant, which serves a city of seven million, can discharge ten million nematodal capsules containing a billion bacteria comprising 250 million coliforms and forty million of the "Bismuth Sulfite Group."

Engineering

A Methodology For Compacting Factory Production Space

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The methodology basically uses industrial systems theory with a state space approach.

Formulae are derived for generation and measurement of "T" values (quantitative design compatibility test values) for the matching of elements and subsystems to display five general classes of area configurations.

The methodology essentially accomplishes two things for the factory systems designer: 1. It generates a table of mathematical values for the relevant design attributes of the logical states of the total population of elements that comprise the factory system. This allows systems structure, in terms of space and flow, to be expressed quantitatively and logically, thereby becoming adaptable to digital computer analysis which can provide increased storage for manipulation of design data and decreased computation time by a factor of thousands as compared to the time required by a designer engaged in the same computations. 2. It provides a method for systematic search of elemental and subsystem area configurations that can be combined to generate optimal subsystem areas within the confines of logical sets that comprise the total factory system population. This search provides a comparison of space fits to be made in quantitative terms – "T" values for the subsystems.

Millimeter Microwave Propagation

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A need exists for accurate data pertaining to the attenuation and phase effects produced by the atmosphere upon the propagation of electromagnetic waves at frequencies above 30 GHz. The previous work performed in this area has been conducted under poorly controlled environmental conditions. In order to alleviate this difficulty, the Electrical Engineering Department at Auburn University has begun construction of a test chamber which will provide controlled conditions.

The test chamber will be 100 ft. in length, 2 ft. in diameter, and will be constructed of stainless steel. The chamber will be lined with absorbent material to reduce reflections. The conditions to be controlled are pressure, temperature, and humidity. A comparison scheme of measurement is to be employed for measuring the relatively small attenuations (of the order of 10^{-4} db) expected.

Under ordinary propagation conditions, the energy spread is very great over a 100 ft. path. Dielectrie lenses will be placed in the chamber to "bundle" the energy and thus reduce losses resulting from spreading. The lenses were designed using quasi-optical theory. This work is supported by the National Aeronautics and Space Administration, Huntsville, Alabama under contract NAS8-11184.

The General Form Of Non-Circular Diffraction Rings

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A sample of polycrystalline sheet produced non-circular X-ray diffraction rings due to its preferred orientation. A general analysis was made showing that the rings are of two types, which are caused by white and characteristic radiation. Those formed by white radiation are projections of the reciprocal lattice. A chart is given showing the various forms in which the diffracted rays lie for individual kinds of reflecting plane, as a function of the inclinations of the plane and the incident beam with the texture axis. The rings caused by characteristic radiation are composed of groups of apparently connected Debye arcs. Their connection is enhanced by large unit-cell size and scatter of crystallite orientations about the orientation of the ideal texture. This analysis is applied to the interpretation of patterns from hot-pressed pyrolytic graphite and is further demonstrated by rotating a single crystal of mica in the path of the X-ray beam.

Electromagnetic Hardness Sorter For Steel Parts

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An electromagnetic hardness sorter for steel has been designed based on the MS and MS' effects. It has been found that this equipment enables one to determine very quickly and accurately the hardness of steel and that it can be used for a continuous check for hardness of mass production parts.

The Mechanical Properties Of Composite Crystals

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The effects of surface coating on the mechanical properties of metal single crystals are presented by means of sensitive tensile tests and electron metallographic observations of surface and coating deformation features. It was shown that coatings affect the shape of the stress-strain curves of these composite crystals and cause changes in the appearance of slip markings both on the substrate, at the interface, and in the coating. This is evidence that the presence of the coating effects a change in deformation mechanism. All effects are attributed to dislocation pile-ups and other dislocation processes. Plans for future experimental and theoretical studies are discussed in relation to the initial observations and the dislocation theory.

Sanitary Survey Of Water Sources In Several Villages In Peru

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The water sources of the Peruvian villages of San Antonio, Cachicoto, Yacango, and Pusi are described. The bacteriological, chemical, and physical characteristics of these water sources are presented. Factors affecting water quality are discussed. Recommendations are made where necessary for improving water quality to meet World Health Organization requirements.

Computer Analysis Of Laue Transmission Patterns

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The indexing of transmission Laue spots which have been translocated into a stereographic projection requires prodigious time and effort of a trained analyst. Because many steps in the indexing are repetitious, a Fortram computer program to achieve the indexing was written to relieve the tedium of the analyst and hasten the availability of the results.

Angular values of the sides of a spherical triangle which are measurements of the angles between three intersecting planes are taken from the stereographic projection of the Laue pattern. The function of the computer program is to produce the Miller indices of trios of planes which intersect at the measured angles. By comparison of the computer results for several adjacent spherical triangles, the analysts can reject those planes which are not likely representative of the crystal and thus arrive at a rapid resolution of the Laue pattern for a cubic crystal.

Resource Allocation Among Competing Projects

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A non-iterative, heuristic method is presented for generating good feasible schedules for operating facilities of multi-project organizations. Each project in the organization is analyzed independently by the PERT critical path procedure. The output from the several PERT analyses serves as input to the scheduling model presented in this paper. Because PERT was applied to each project independently, schedule conflicts will result when specific jobs are assigned to specific operating facilities. The objective of this scheduling model is to resolve the schedule conflicts such that total schedule slippage among all the projects is minimized. When applied to several small sets of hypothetical data, the method yielded consistently better results than the commonly used single attribute decision rules of "shortest operation first," "first come, first served," and "longest remaining network time."

Detergent Removal By Soil Adsorption

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The quantity of ABS adsorbed by selected soils and the effect of solute concentration and soil particle size on removal were investigated by applying varying ABS concentrations to soil columns. The total quantity of ABS removed was determined for each soil type at various ABS concentrations. It is shown that the removal follows a modified Freundlich isotherm and that ABS removals increase with an increase in ABS concentration and also with a decrease in soil particle size.

The Ponding Of Rainwater On Flexible Roof Systems

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The problem of roof failures under rainfall was introduced. The results of studies on the response characteristics of flexible beams under liquid loads were presented. The primary variable in such problems is a dimensionless ratio $R = \frac{\gamma B L^4}{\pi^4 EI}$, where γ is the unit weight of the liquid, B is the beam spacing, L is the span, and EI is the flexural rigidity of the beam. Where R is less than 1.00, a sub-critical case results, whereas when R is greater than 1.00 a super-critical case results.

Curves were shown from which deflections, weight ponded, and bending moments could be determined for sub-critical and super-critical beams.

VLF Propagation Studies

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The purpose of this paper is to describe a system for studying the phase stability of propagated VLF signals and which will eliminate errors resulting from the antenna and frequency references of the system. The proposed system is a two-way transmission system in which a signal at frequncy f_1 is transmitted to a transponder station, where it is then re-transmitted at a phase-coherent frequency f_2 slightly offset from f_1. The signal of frequency f_2 is received at the

reference station, and, after being phase-coherent frequency offset, is then compared in phase with the transmitted frequency f_1. The total measured phase shift over the path may be directly attributed to the propagation medium. The data obtained from the experiments utilizing this system are to be used to furnish information concerning phase and amplitude stabilities, at very low frequencies, which result from variations in the propagation medium, and from the associated transmission system.

The objectives of the very-low frequency propagation study utilizing the described system are two-fold: (1) to provide more accurate information concerning the propagation characteristics and phase stability of very-low frequency signals; and (2) to investigate the possibilities of using very-low frequency signals in direction finding and in accurate location problems. This work is supported by the National Aeronautics and Space Administration, Huntsville, Alabama under contract NAS8-20154.

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